THE SCIENCE TEACHER

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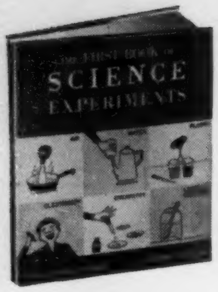

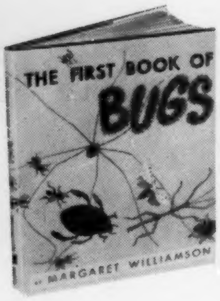

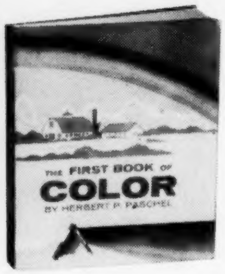

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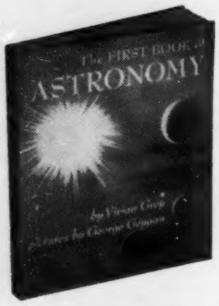

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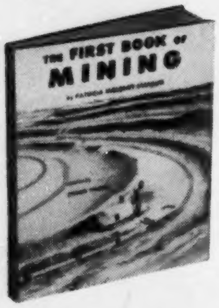

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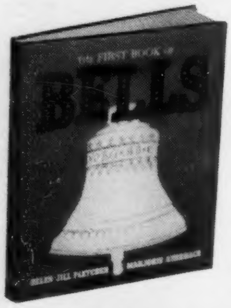

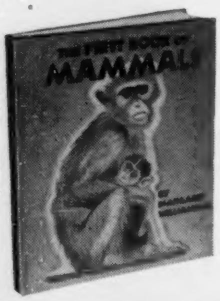

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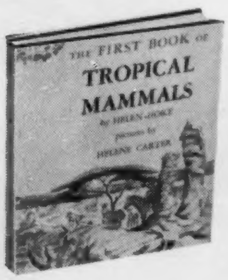

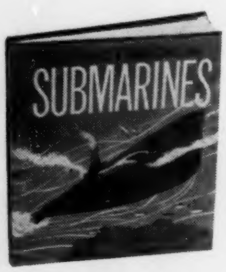

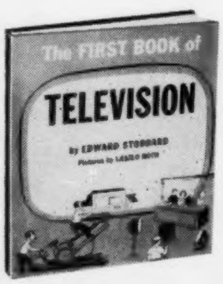

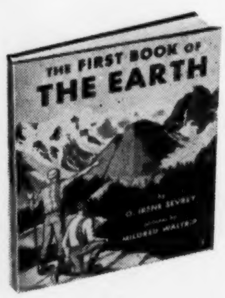

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THE SCIENCE TEACHER

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The National Science Teachers Association is a department of the National Education Association and an affiliate of the American Association for the Advancement of Science. Established in 1895 as the NEA Department of Science Instruction and later expanded as the American Council of Science Teachers, it merged with the American Science Teachers Association and reorganized in 1944 to form the present Association.

Journal of the National Science Teachers Association
Volume 27, Number 4 • May 1960

Editorial

The Heart and the Mind of NSTA

Nine months ago in the Anniversary Issue of *TST* (September 1959) I wrote an article titled, "Beyond This Issue Toward Infinity." I started my article with this sentence: "All predictions of the future will some day be lost in the realities of the present." This has now come to pass.

This editorial might well be a report of the predictions made and the realities of those predictions nine months later. But the predictions and their realities seem of little consequence to me since they deal with organization, administration, budget, committees, international activities, and convention purposes. They are of little consequence because of something that is of much greater significance to me than the routine affairs of the organization and the improvement of them. The most important, rewarding, and humbling experience was the discovery of *the heart and the mind of NSTA*.

In my fondest dreams I had not anticipated the full measure of cooperation, the devotion to the Association, the willingness to dream and turn the dreams into realities, the mutual respect and admiration of member for member, the intense professional interest in all activities, and the desire to serve the interests and the needs of the Association far beyond the normal contribution of individuals to a professional organization. But these I found in the hearts and the minds of the members of NSTA and the officers they elected. But even more than this I discovered the deep human qualities of individuals expressed in interest, and sympathy, and understanding for other members, and for their students, and their associates in science teaching.

We have an organization of which we have always been proud, but more than that we have a membership devoted to the interests of each other, dedicated to the hard work that teaching is, and endowed with the capacity for enjoying, as well as fulfilling the responsibilities of, the life and the times that belong to us.

So nine months later I find myself unimpressed with the predictions of the future and very impressed with the quality and maturity within the NSTA organization. The privilege of serving as Association President for this year has been mine. It is with deep appreciation and genuine humbleness that I express to you, the members of NSTA, and especially to Robert Carleton and his staff, the Executive Committee, and the Board of Directors, my thanks for a fruitful year.

I know that the entire membership joins me in welcoming our new president, Mr. Robert Rice, who embodies all of the qualities considered important by our Association, and who will, I am sure, find his work for NSTA a rich experience.

DONALD G. DECKER
President, NSTA (1959-60)

THE SCIENCE TEACHER

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* Includes the *Elementary School Science Bulletin* published monthly from September through April of each year.

My first reading of the article entitled "Biology Achievement in Grades 9 and 10" in the March issue of *TST* led me to believe that the conclusion was valid. However, after careful consideration and thought, I was convinced that the approach was unscientific. To the best of my knowledge, an experimental group and a control group should differ in only one respect. After a relationship has been established for one variable, then a second independent variable may be introduced. At the onset, the reader is told that: "These ninth-grade biology students were selected on the basis of their *interest in science* and *in science-related careers.*" ". . . The senior high school pupils in the study were *those who were enrolled* in the standard biology course." (My italics.) One variable is age, but there are also a host of others!

What were the interests and career choices of the tenth-grade group? How many did not enjoy science? How many planned to leave high school prior to graduation? The study gives no clues to the answers to these and many other similar questions. Why weren't the results of science-interested ninth- and tenth-grade students compared?

In the near future, using the experimental protocol of the authors of this article, I am reasonably sure that I can prove *statistically* that ninth-grade students will score higher on tests after the completion of the PSSC* physics course than uninterested eleventh-grade pupils. As a result of that study I shall show that physics can be taught successfully in grade nine!

Which question is more important? At what grade level *can* biology be taught? Or at what grade level will the students *profit the most* from biology? If there is an answer to the latter question, then the answer is provided in the article entitled "Concerning Ninth Year Biology" by Philip Goldstein (*The Science Teacher*, December 1958). The answer: Biology in Grade 10!

JOEL BELLER
Richmond Hill High School
Richmond Hill, New York

* Physical Science Study Committee.

It always disturbs me when I see mean scores compared in an article. I am even more disturbed when an obtained mean score is compared with an expected mean score. We will always have differences between mean scores. But are such differences really *significant?*

In Professor Heidgerd's article, "More on Ninth Grade Biology" (March 1960 issue), he treats as significant a difference between an obtained mean score and an expected mean score on the Nelson Biology Test. I frankly doubt that the difference he has found in any way justifies a negative attitude toward a plan for ninth-grade biology.

MARTIN STEWART
Associate Professor, Department of Science
State Teachers College
Cortland, New York

NEA NOTES

EDITOR'S NOTE: From time to time, we will report events and data of interest from other NEA departments in this column. Additional information on the items reported may be obtained by writing the individual departments.

Cooperative project in learning

Two NEA departments have just issued a new handbook for parents, *How To Help Your Child Learn.* The 40-page booklet is a joint project of the Department of Elementary School Principals and the National School Public Relations Association.

How To Help Your Child Learn takes parents from kindergarten through the sixth grade, explaining the building of learning experiences in various curriculum areas.

Science, the booklet points out, is exciting to a child: "Note the clinical gaze he turns on a praying mantis devouring a live grasshopper . . . or note him at breakfast, momentarily distracted from the main business at hand by egg yolk on the silver spoon (he's been learning what happens when silver and sulphur get together)."

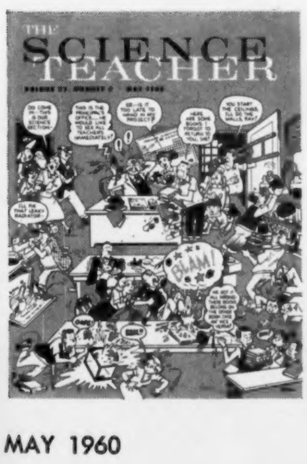
Included are suggestions to help parents broaden their child's science learning at home—and work cooperatively with his teachers.

American Association for Health, Physical Education and Recreation

Recent research showing that American children and youth need more vigorous activity to maintain health and fitness has influenced the program of the AAHPER, a department of NEA. National norms developed by AAHPER for selected fitness test items are being used throughout the country for testing and evaluating student progress. Programs to stimulate more participation in activities such as track are under way in many local communities.

In health education, the emphasis is on improved instruction through conferences on the preparation of health teachers, evaluation of pupil knowledge and practices, and study and revision of the health education curriculum. Several commissions are carrying through on these projects.

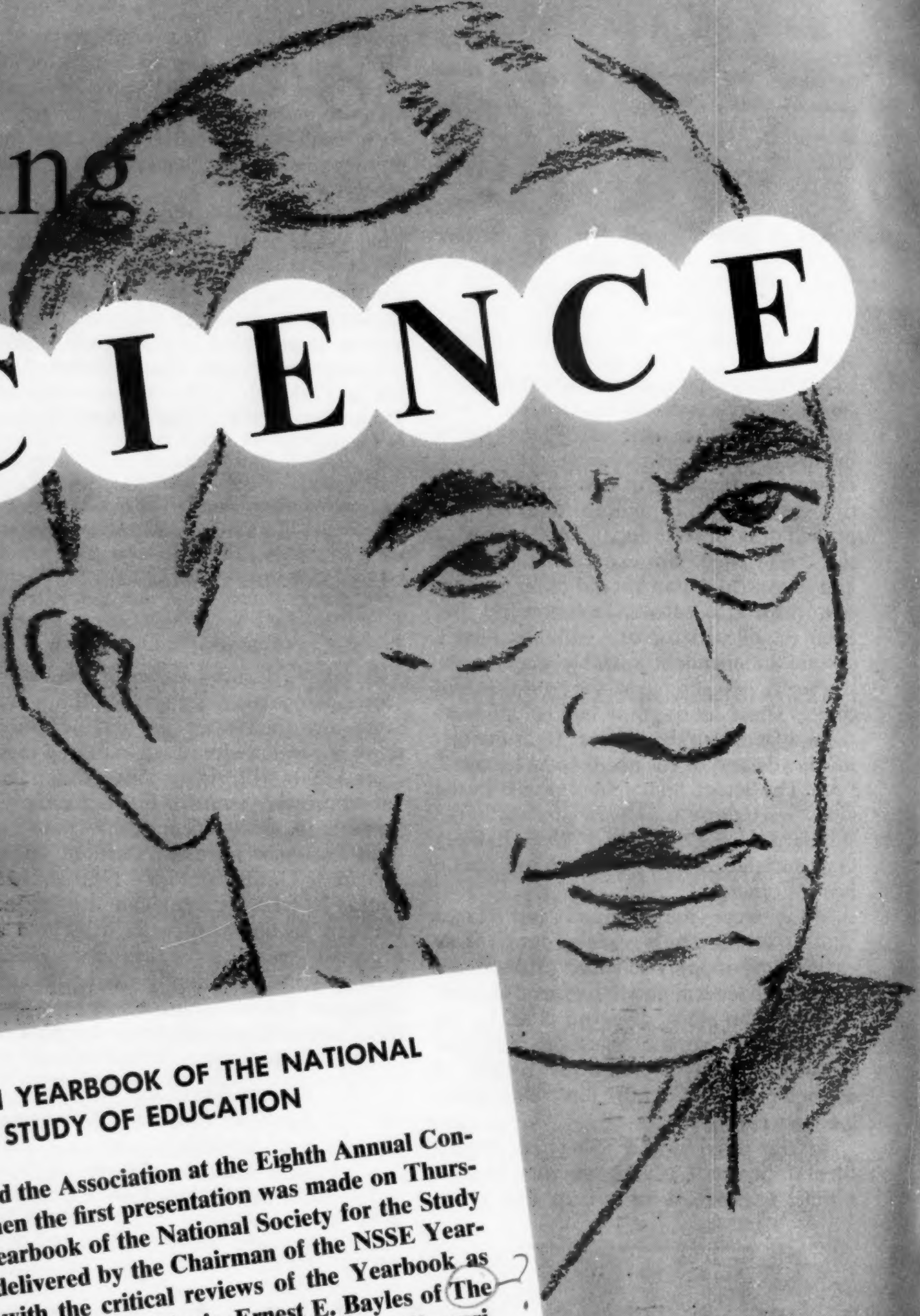
Developing the community school concept is the central focus of our recreation people. Two recent national conferences involved school administrators and community leaders. More school systems are accepting the responsibility of providing programs of education and recreation for the entire community. Related to this is the area of outdoor education and family camping. AAHPER is working with the NEA Division of Travel on a family camping program for teachers.



THIS MONTH'S COVER . . .

The multiple incidents which happen to plague many of our teachers during the closing days of school have been captured in one central theme by our guest artist, Joseph W. Musial of Manhasset, New York. Mr. Musial is the creator of the current cartoon series known as The Katzenjammer Kids which appears as a King Features Syndicate newspaper presentation. Mr. Musial has been an NSTA member for over ten years, and participates in our program as a citizen much interested in the advancement of science education through professional association activities.

Rethinking SCIENCE

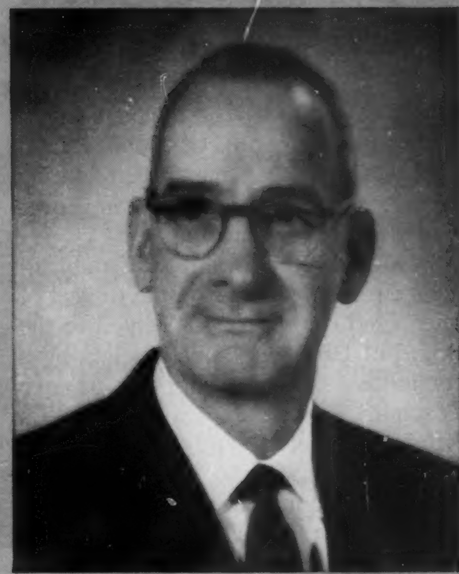


PART I OF THE FIFTY-NINTH YEARBOOK OF THE NATIONAL SOCIETY FOR THE STUDY OF EDUCATION

Recognition and honor were accorded the Association at the Eighth Annual Convention in Kansas City, Missouri, when the first presentation was made on Thursday, March 31, of the Fifty-ninth Yearbook of the National Society for the Study of Education. The presentation, as delivered by the Chairman of the NSSE Yearbook Committee, follows together with the critical reviews of the Yearbook as prepared by J. Myron Atkin of the University of Illinois, Ernest E. Bayles of The University of Kansas, and Edward M. Palmquist of the University of Missouri.

The Association considers it a signal honor to have been designated as the agency to name the members of the committee and to have been the source of most of the contributors whose combined efforts have produced the current volume. The Yearbook Committee of five included: J. Darrell Barnard, Chairman; Glenn O. Blough, University of Maryland; Paul DeH. Hurd, Stanford University, California; Ellsworth S. Obourn, U. S. Office of Education, Washington, D. C.; and John S. Richardson, The Ohio State University. This committee was augmented by an officer from each of the cooperating societies, Robert H. Carleton (for NSTA) and Robert J. Havighurst (for NSSE).

EDUCATION



J. DARRELL BARNARD

Author, teacher, administrator, and consultant, Dr. J. Darrell Barnard has long been active in the field of science education on the elementary, secondary, and college levels. He attended Colorado State College of Education for his BA and MA Degrees, and received his Doctorate from New York University. In NSTA's recent election of officers, Dr. Barnard was chosen by the membership to be President-elect during the year ~~of~~ 1960-61.

Presentation

By J. DARRELL BARNARD

Chairman of Yearbook Committee of NSSE, School of Education, New York University, New York City

THE National Society for the Study of Education annually publishes a yearbook in one or more parts dealing with selected subjects to be investigated in the field of education. Since the inception of its yearbook series in 1902, three volumes have been designed to provide new emphases or directives to

NOTE: Copies of the yearbook are available through The University of Chicago Press, Chicago 37, Illinois. Cloth-bound, $4.50 each; Paper-bound, $3.75 each.

current practices in science teaching. The first of these publications, Part II of the Third Yearbook (1904), entitled *Nature Study,* was published with the view of establishing a functional relationship between elementary instruction in science and the natural sciences in the secondary schools. Part I of the Thirty-first Yearbook (1932), developed *A Program for Teaching Science,* which was directed toward the attainment of an understanding of the major generalizations of science and the associated scientific attitudes. Part I of the Forty-sixth Yearbook (1947), *Science Education in American Schools,* urged further recognition of fundamental values in the advancement of scientific knowledge as well as in the improvement of science education.

The possible desirability of publishing a current yearbook on the subject of science education was presented to the Board of Directors of the Society by a committee of the National Science Teachers Association in May 1957. After careful study and formulation of general purposes and plans, the proposal was approved and a committee as named above was appointed in October 1957 to proceed with preparation of the current volume, *Rethinking Science Education.*

The yearbooks mentioned above were conceived by educational leaders of the period. They were written primarily by committees of professional educators. The yearbooks have found wide use among those vested with the responsibility for the education of science teachers. For professional educators who had been relatively alone in their active concern about the improvement of science teaching, the yearbooks have been indispensable resources in supplying authoritative guidelines.

Today the professional educator is not alone in his concern about the improvement of science teaching. Neither is he alone in his overt efforts to do something about it. Science in the schools has become everybody's business. Organized citizen groups, leaders in business and industry, science faculties of colleges and universities, and agencies of our federal government, all are showing more interest in the improvement of science teaching. And many of them have become active in doing something about it.

Within the past ten years there has been a profusion of public statements and published reports dealing with various aspects of the science-teaching problem. The motivation has emanated from dramatized incidents of the increasing significance of science in modern society and from an apparent shortage of professionally trained manpower. The statements have come from a wide variety of sources. In some instances they have dealt superficially with the problem. In others they have considered only one aspect of the larger problem. At the time this yearbook was conceived none of these pronouncements had considered the larger problem in its broader educational setting. This was the task that the yearbook committee set out to accomplish.

There are always purposes or hopes underlying projects such as this one which give form to the project's design and determine the manner in which it is to be carried out. Our committee had at least two such purposes in mind. From the beginning we had hoped that professional science educators, supervisors, school administrators, school board members, classroom teachers, and other knowledgeable people, who are interested in science teaching, would find the finished product helpful. This meant that the yearbook had to be designed for an audience with varied backgrounds and interests in science education. We had also hoped that the yearbook would be representative of best thinking from a number of informed points of view. This meant that many people, other than the seven members of the committee, had to become involved in preparing the materials for the yearbook. In the final count there were eighty-seven contributors.

An examination of the outlines for the eighteen chapters as summarized in the table of contents reveals the comprehensive nature of the yearbook. The first six chapters serve as a foundation for, and introduction to, the twelve chapters that follow. In the first two chapters various roles of science in our culture are examined and the purposes of science education reassessed in light of various conceptions of these roles. The next two chapters are focused upon learning, creativity, and personality as they relate to the achievement of various purposes in science. The present status of science teaching from kindergarten through the junior college are reviewed in Chapters V and VI.

This background material is followed by two chapters given over exclusively to science in the elementary school. These deal not only with the development of science programs in the elementary school, but also with teaching and evaluating such programs. Although no single pattern for the development of an elementary science program is recommended, guidelines are proposed for this level.

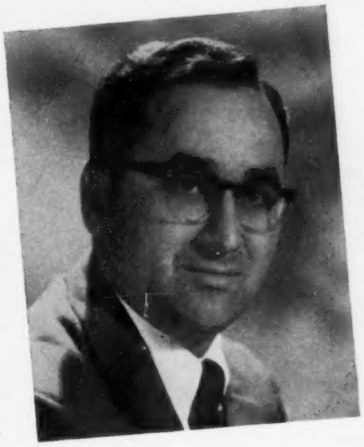
In the two chapters on secondary school science, some of the problems are defined which bring teaching practices more nearly in line with accepted theory. Proposals are given for dealing with these problems, and the various auxiliary efforts that are currently being made to improve secondary school science are reviewed.

Two chapters deal with curriculum development and supervision of the science program. There is an extensive treatment of facilities, equipment, and instructional materials in Chapter XIII. The education of science teachers and their professional growth are considered in the next two chapters.

The areas of needed research in science education and the question of who is to do it are critically examined in Chapter XVI. Implications of what has been written about science education in this yearbook for colleges and universities are identified and discussed in Chapter XVII.

The final chapter is given over to brief comments upon the problems and issues in science education. These are the problems and issues which the committee has identified as a result of its work in preparing the yearbook. The identification of these issues might be viewed as one of the major contributions of *Rethinking Science Education.* Many of the topics should properly become subjects of subsequent yearbooks which probe more deeply than was possible under the plan of the current comprehensive volume.

If there ever were a time, the time is past when we can justify an interim of fourteen years between yearbooks on science education. In view of the many pressing issues and problems in science education today, it is imperative that an association such as NSTA assume sponsorship for a series of annual yearbooks to place before the profession the best thought, experience, and research concerning these problems and issues. Such a series should become the immediate concern of NSTA.



J. MYRON ATKIN

A native of Brooklyn, New York, Dr. J. Myron Atkin completed his Doctorate at New York University in 1956. He has been associated with the University of Illinois since 1955, having served previously as a high school science teacher and an elementary school science consultant. Dr. Atkin is the author of several books and articles on science education and is a consultant on teaching materials.

Critique A

By J. MYRON ATKIN

Associate Professor of Education, University of Illinois, Urbana, Illinois

THE publication of an NSSE yearbook on science education is always a signal event. The yearbooks of 1932 and 1947 served as valuable benchmarks reflecting what was considered the best of contemporary practice and also giving direction for the future development of science education. In the new yearbook, the same tasks are attempted: What is best current practice? In which directions will the science education enterprise move? Most readers will find that the Fifty-ninth Yearbook is thorough and accurate on the first question. Some will find the yearbook thorough, but somewhat inconsistent, on the second.

Consistency is not a particularly strong virtue in a symposium. If the attempt is made to solicit contributions from several scholars, it must be expected that the scholars will disagree, particularly in attempting to forecast the future. In a field characterized by as much flux as science education today, no one has a clear crystal ball.

Perhaps a strong virtue of inconsistency is that differences of viewpoint may lead the way to the most crucial issues. Certainly differences are apparent in reviewing those aspects of the yearbook relating to elementary school science. Shamos (p. 2-7) quotes Poincaré: "The scientist does not study nature because it is useful; he studies it because he delights in it, and he delights in it because it is beautiful." Shamos implies that the best science study immerses one deeply in the discipline; he says that impressions of science based on its social utility are false impressions. Rogers (p. 19-22) stresses the same theme. We must stop teaching "description and results." Emphasis should be placed "on where scientific knowledge comes from, how it is gained, codified, and reinterpreted through speculation." To accomplish this end, says Rogers, we must drastically reduce the content to be covered.

Yet in Chapter VII a strong plea is made for studying in the elementary school those aspects of science with greatest social implication. "Children in the elementary school should have experiences in deciding how and whether to use scientific knowledge in situations of social significance" (p. 119). Again, "Social studies which . . . includes geography, history, and civics, is, of all subjects, the one most closely allied to elementary school science. Its concern with problems of living and working together in the home, school, neighborhood, community, or country makes social studies a good background for many science activities" (p. 123). And on page 315 approval is implied for a college level course in science for prospective teachers based on "problems of everyday living."

A clear implication for this reader of these apparently conflicting viewpoints is that the selection of content for elementary school science programs is a paramount, controversial issue. Should science content be selected for elementary school study that is fundamental to the various scientific disciplines as those disciplines are viewed by recognized professional scientists? Or should content be selected because it helps the youngster recognize how science is utilized in daily living in the year 1960? This issue is recognized as crucial by the yearbook committee and stated succinctly on page 330.

Points of agreement among the contributors are more evident than the points of disagreement. All contributors seem to share the view of one that science is a "search for order in nature" and that science education should place greatest stress on the "search." This conviction is expressed in a variety of ways. There is considerable discussion of children's thinking, all of it pertinent and informative. Chapter III furnishes much revealing information about how children learn science. Improvement of problem-solving ability and critical thinking ("scientific method" to others) are held as important goals by all contributors to the yearbook, although one (Rogers) fears that such aims, which he calls the "higher virtues," are unrealistic in the school setting.

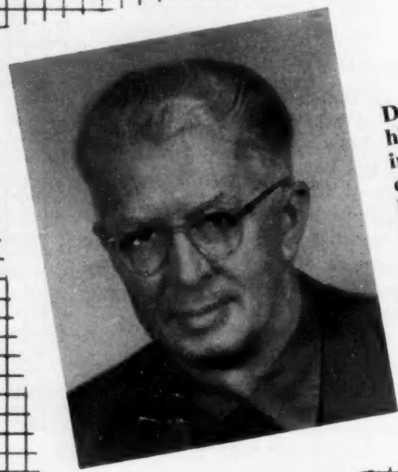
It seems that considerable research is necessary related to improvement of critical-thinking abilities. This objective serves as a unifying theme among virtually all science educators, and the yearbook serves admirably to cite most of the significant research related to the problem as well as to point directions for further investigation.

The Fifty-ninth Yearbook is certainly the most significant contribution to the general literature of science education in more than a decade. Perhaps many readers will feel, with this one, that this new yearbook represents an even more ambitious attempt to collate varying views than the preceding yearbooks in the series, and therein lies its greatest value. One finds between two covers the distilled views of those who have been exerting strongest leadership in the science education field for the past twenty years.

Critique B

By **ERNEST E. BAYLES**

Professor of Education, The University of Kansas, Lawrence, Kansas



ERNEST E. BAYLES

Dr. Ernest E. Bayles is well known for his many articles and books on teaching theory, educational philosophy, chemistry, and biology. In addition to his duties as general editor of a teaching series, Dr. Bayles serves as consultant for educational films. His latest book, "Democratic Educational Theory," represents the development of over thirty years of thoughts on the tenets of a comprehensive, consistent, and a practical democratic educational program.

I WONDER somewhat whether the title of the yearbook, *Rethinking Science Education,* is justified, since in it I find shortcomings much like those which I found in the Thirty-first Yearbook and on which I commented in two different articles published in 1932.

Sharply brought home to my thinking by Chapter XIV on the education of science teachers is the feeling that mid-century has witnessed much of clear and definitive change in science itself, but little in science education. The science content of a science teacher's preparation has been clearly altered by present-day findings and thinking, but the same cannot be said of the portion of a science teacher's preparation for which science-education personnel do have a responsibility.

As recognized at various points throughout the yearbook, albeit in hit-and-miss fashion, a teaching program needs to be clear on assumptions regarding (1) the social order of which it is to be a part and (2) the nature of learners and of learning. Out of these can, and should, come an understandable statement of educational purpose, from which deductions can easily be made as to both what to teach and how to teach. If we are noncommittal or indefinite on these matters, we have certainly fallen short professionally. That is what distresses me about the yearbook, if not about science education in general. I find no clear commitments on any of these matters. I believe that is why it follows that: "Although high school science teachers and science educators have assisted with the development of these [science] courses, the scientists have played a major role in defining the purposes of the courses and the organization within which they will be developed" (p. 157). Is it not too bad that such an admission has to be presented or even made?

Let us be specific. The title of Chapter III is, "How the Individual Learns Science." After several pages liberally interspersed with a profusion of undefined terms such as "concepts," "meanings," "generalization," "inductive method," "deductive approach," "percepts," "conceptual thinking," "critical thinking," "reflective thinking," "creative thinking," "productive thinking," "problem solving," "judgment," "scientific method," etc., we are then taken to statements such as: "The principles of learning which are to be observed in teaching directly for the attitudes and methods of science are the same as those applicable for any other educational objective," and "The experiences should be psychologically sound, with due cognizance given to student aims and needs" (p. 48). How noncommital can one get? Then we go to the determination of scientific aptitude and the "obstacles to measuring learning in science." I submit that in this entire chapter there is no enlightenment on how an individual learns science.

Next, although in Chapter II it is stressed that elementary and secondary science education should be mainly concerned with the needs of lay citizens, Chapter IV is devoted entirely to the qualities of scientists. Then we are regaled with the old clichés: "There is no one scientific method; in fact, there are almost as many methods as there are scientists and problems to be solved" (p. 35) and, "Obviously there is no *one* best method for teaching science. . . ." (p. 136). As a result, there is no clear commitment anywhere as to the essential nature of scientific problem solving and, in consequence, none regarding the kind of teaching which is necessary to promote it. I find no evidence of realization that, as widely used, critical thinking and reflective thinking do not mean the same at all; hence, their employment in the yearbook as terms which are essentially synonymous is highly confusing. Coming to know is one thing; using what one knows is quite another. I think that reflective thinking or problem solving can legitimately be used only for the former, and I find critical thinking widely used to designate the latter; thus, the confusion in treating them as synonyms occurs.

In such limited space one cannot help but appear brusque and dogmatic, but, for reasons given and for many others, I am forced to report that I find the Fifty-ninth Yearbook disappointing.

EDWARD M. PALMQUIST

Dr. Edward M. Palmquist is Professor of Botany at the University of Missouri. He has also been Associate Dean since 1956. Concurrently he has served as Chairman of the National Science Foundation's panel evaluating Academic Year Institutes. Dr. Palmquist received his Doctorate from Columbia University in 1936. He is an active member of many educational societies and panels and has authored a number of publications in science education.

Critique C

By EDWARD M. PALMQUIST

Associate Dean, College of Arts and Science, University of Missouri, Columbia, Missouri

MY assignment as a member of the yearbook panel is to describe my reactions to the yearbook *Rethinking Science Education* with respect to its implications for higher education. It is my understanding that its significance for elementary and secondary education are presented by others. My remarks are confined, therefore, to its bearing on science programs at the collegiate level.

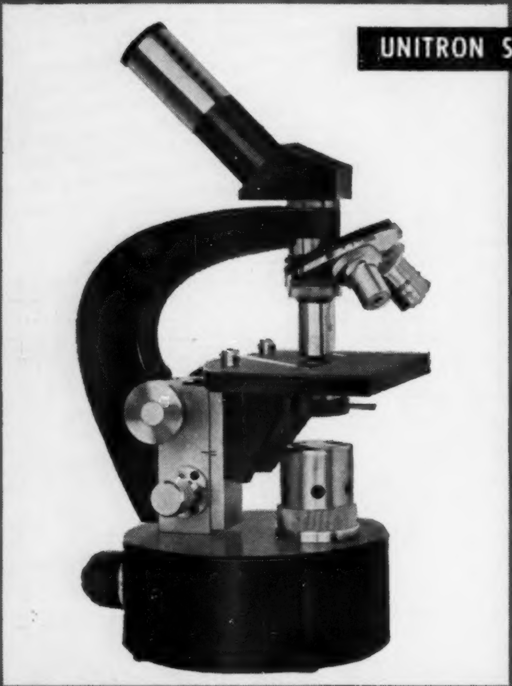
One reason for "rethinking science education" now is that science is playing an ever-increasing role in our culture. Certainly, the culture of twentieth-century western civilization is characterized by a phenomenal development of science and its applications to almost every aspect of living. The opening chapter of the Fifty-ninth Yearbook of the National Society for the Study of Education makes this point well. It also includes an excellent commentary on the place of pure science, along with the humanities, in our culture.

The growing prominence of pure science as an element in our culture and the critical importance of applied science to the welfare and security of nations have far-reaching implications for science programs in our colleges and universities. The contributors to the yearbook do not go as far as Bentley Glass does in his recent book, *Science and Liberal Education,* in which he argues that science must become the core of a liberal education. (See Book Reviews.) They do, however, make a number of concrete suggestions to colleges for improving the quality of undergraduate teacher-preparation programs and for aiding the in-service secondary school science teacher. Among the suggestions that I consider worthwhile are: that about one-half of the undergraduate program for the preparation of high school science teachers consists of courses in the subject matter of science, in contrast to the one-third or one-quarter characteristic of many current programs; that science be understood "as a continuing process of inquiry, not as a set of firm answers to particular questions"; that prospective science teachers be given some understanding of the relationship of science to our culture; that high school teachers be prepared to develop courses in which their superior students may qualify for advanced placement programs upon entering college; that colleges provide aid for their graduates who are teaching science in high school, particularly during their first year of teaching; and that the importance of a "teacher-pupil project room" be stressed.

Rethinking Science Education will be of greatest value to those concerned with elementary and secondary school programs, particularly the latter, for it is most specific at these levels. It includes some information concerning the present status of science teaching in junior colleges and technical institutes, but it does not deal directly with the collegiate education of prospective scientists or with the currently urgent problems of preparing teachers of science for our junior and senior colleges.

Of special value to those concerned with the broad problems of science education are the descriptions of the present status of such aspects of the field as national programs for teachers, sponsored by various government and private agencies; the discussions of promising avenues of research in science education; and the many lists of important references throughout the book. College teachers and administrators will profit from the perspectives presented in the early chapters and will find guidelines in the later chapters for developing college programs of teacher preparation in science education.

UNITRON student microscopes offer



UNITRON STUDENT AUTO-ILLUMINATION MICROSCOPE, MSA

The UNITRON Student Auto-Illumination Microscope, Model MSA, employs a newly designed stand in which all components and controls are within easy reach. The inclined eyepiece tube allows comfortable posture and may be turned in any optional observing direction to permit two students sitting side by side to share a single instrument. With the built-in illuminating system of the superior low-voltage type, each student is assured of the correct lighting. The transformer is conveniently housed in the microscope base itself where it contributes to the stability of the stand rather than to the clutter of the laboratory table.

Model MSA comes complete with triple revolving nosepiece and three objectives: 4X, 10X, 40X; three eyepieces: 5X, 10X, 15X; coarse focusing with safety stop; fine focusing; condenser and iris diaphragm; filter holder and filter; accessory substage mirror; wooden cabinet and dustcover. Mechanical stage available at extra cost.

Unit price $107
11-24 units $94.16

5-10 units **$96.30**

UNITRON STUDENT MICROSCOPE, MUS

Despite its low cost, UNITRON Model MUS offers features lacking even in much more costly models usually offered for student use. For example, both fine and coarse focusing are provided — not merely a single focusing control; an iris diaphragm to regulate aperture for highest resolution — not merely a disk diaphragm; and a condenser system for optimum illumination.

The optical performance of Model MUS at each of its magnifications is equivalent to that of expensive research models. All mechanical parts are machined to close tolerances and the stand is beautifully finished in black and chrome. Model MUS comes complete with triple revolving nosepiece and three objectives: 5X, 10X, 40X; choice of two eyepieces from: 5X, 10X, 15X; coarse focusing (accessory safety stop available); condenser with iris diaphragm; inclinable stand; plano-concave mirror; wooden cabinet and dustcover. Mechanical stage available at extra cost.

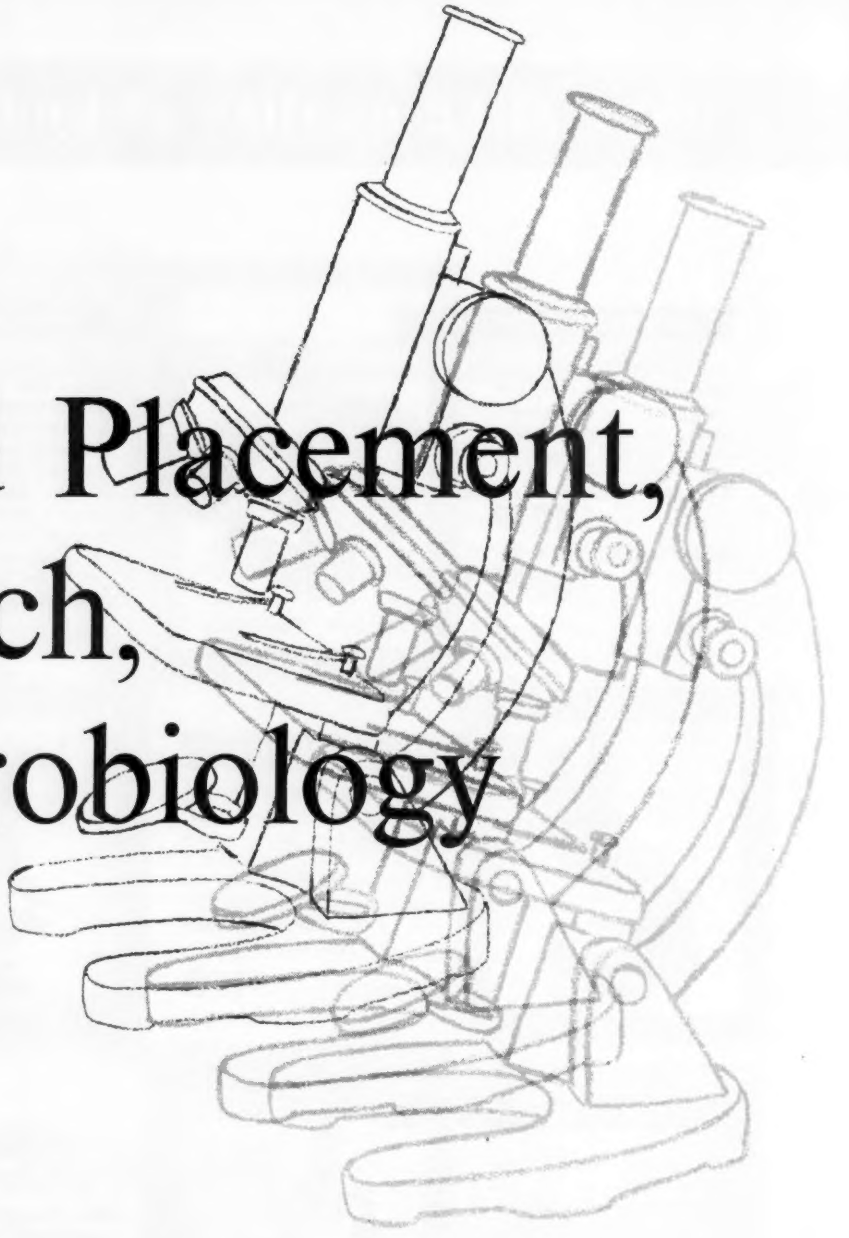
Unit price $74. each
11-24 units $65.12

5-10 Units **$66.60**

Model MUS-ND: As above but with two objectives: 10X, 40X; single 10X eyepiece.

Unit price $61.75
11-24 units $54.34

5-10 units **$55.58**



Advanced Placement, Research, And Microbiology

This article and the four which follow are representative of some of the prize-winning entries which received cash awards in the STAR (Science Teacher Achievement Recognition) program of 1960. In the section under "Classroom Ideas," we have also selected other representative entries as noted. The program, conducted by NSTA, was sponsored for the third time by the National Cancer Institute, U. S. Public Health Service.

By PAUL KAHN

Teacher of Biology, Bronx High School of Science, New York City

FOR an increasing number of schools in America the answer to the challenge of science education in the space age seems to be "Advanced Placement." The existing state of affairs is reminiscent of the football team that, at the call of "Shift," collectively advanced one pace. So, too, has science for the gifted: college freshman science is being placed widely in the high school senior position, biology (or is it earth

NOTE: The author is currently serving in his new capacity as Assistant Principal at Hoffman Junior High School, Bronx, New York.

or physical science?) may shift to the ninth grade, and junior high school general science moves to the elementary level. But the changes appear to raise more questions than they answer. Are the youngsters mature enough to profit from the science at the lower level? Is there a co-ordinated science program throughout the grades? Does proper articulation prevail from school to school? Is "Advanced Placement" calculated to whet and satisfy the appetite of the "science-hungry" child? Will more students enter scientific fields by virtue of the changes?

To undertake the solution of these or similar problems would require a major, comprehensive effort. Lacking this endeavor, some science educators advocate what they call *Research Seminars* for the gifted student. In such courses talented high school or junior high school pupils engage in original research, aided by teachers, parents, and industrial or institutional investigators. Adherents of the seminars maintain that students electing them acquire a lasting interest in science, master scientific methods and attitudes, and become much more proficient in modern laboratory techniques.

No one can argue with assurance as to the claims and counterclaims of either group. But one can scarcely help wondering whether the merits of both cannot be combined: for the high school, a college-quality science course with research potential; for the junior high school, a high school-quality course with research potential. Experimenting over the last three years, the author has developed a course in microbiology which he believes meets these requirements at the high school level. It is based upon a standard college bacteriology course (e.g., the one taken by the writer at the College of the City of New York) and upon a pre-existing Laboratory Techniques course offered at the Bronx High School of Science and a number of other New York City high schools. To the foregoing matrix was added a high percentage of up-to-the-minute microbiological research techniques, methods, and problems and the entire area expanded to include a wide choice of microorganisms. The resulting course might well be termed *Research Microbiology*.

Before proceeding to the "meat" or content of the course, let us visualize its advantages. Compared with a research seminar, microbiology does not require the teacher to be acquainted with research techniques in the over-all science field. Nor does it request a wide variety of scientific equipment or the assistance of outside research workers who are often jealous of their time and projects. Compared with an "Advanced Placement" course which cannot guarantee advanced placement (students must successfully complete a special examination with grades high enough to be acceptable to the college of choice), microbiology would only have to be elected out when the student arrives at the proper point in his college science career.

What would the course be like? A detailed outline intended to cover a full year's work is given below. The subject is subdivided into units which are presented in the form of problems and which offer a definite sequence. All or every part of the units do not have to be completed nor must the sequence be slavishly followed. Each unit-problem finds its answer by means of a series of techniques for student performance and concludes with a choice of allied problems for further application. The course closes with the student's submission of a research problem of considerable depth—one of his own selection.

Unit I. What is the structure and behavior of some microorganisms?

TECHNIQUES

1. Making flat, wet mounts of microorganisms such as *Euglena, Tetrahymena,* yeast, or molds.
2. Applying physical factors including electricity or heat and adding chemicals to the mounted drops by loop or dilution methods.
3. Preparing hanging-drop cultures.
4. Staining microorganisms by simple and differential techniques. (See photograph below.)
5. Measuring size, counting numbers, and isolating microorganisms.

PROBLEM

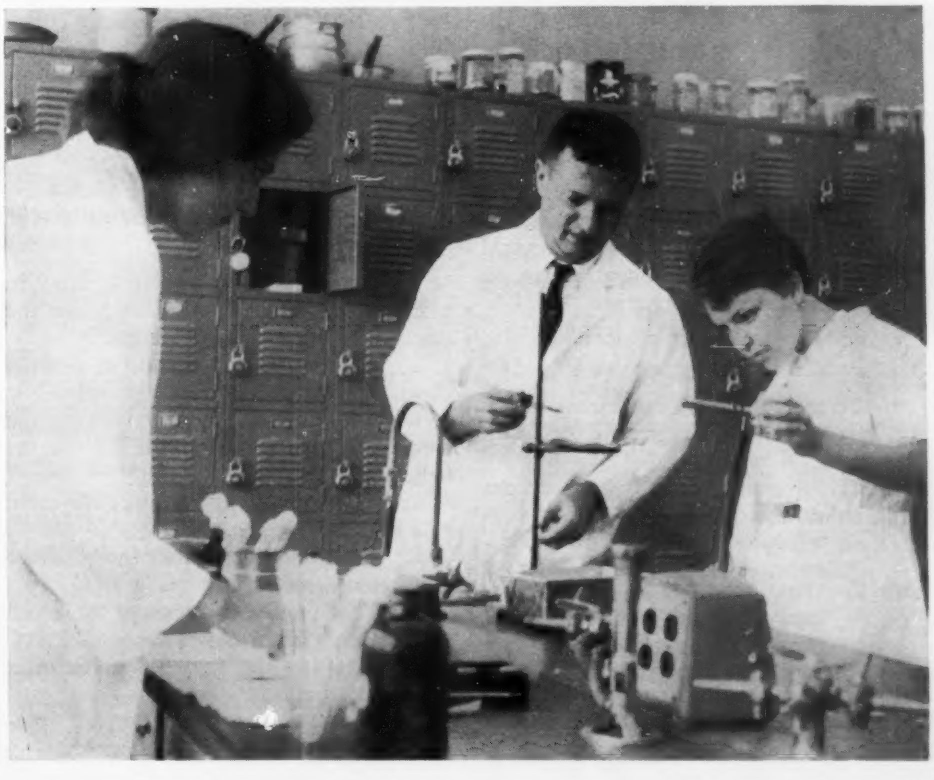
To determine the structural and differential characteristics of an unknown microorganism.

Unit II. Where are microorganisms found in nature?

TECHNIQUES

1. Collecting samples of soils, water, plants, animals, and their products.
2. Preparing pour plate cultures by exposure, inoculation, streaking, and swabbing.
3. Using a colony counter to compare numbers and kinds of microorganisms.
4. Setting up serial dilutions by decimals of soil, water, and milk.

Author demonstrates staining microorganisms by simple and differential techniques.



PROBLEMS (Choose One)

1. What is the minimum time exposure to ultraviolet light needed to prevent growth of *Serratia marcescens?*
2. In which part of the school building is the air most contaminated? Will a given aerosol reduce the pollution?
3. How many different molds does a soil sample from the school grounds contain?
4. Is a given sample of milk or water bacteriologically pure?
5. Will intake of asparagus modify or reduce the microbial population of human urine?

Unit III. How do microorganisms grow and reproduce?

TECHNIQUES

1. Preparation of tubed liquid and solid media. (Potato, nutrient broth, litmus milk, peptone broth, and nutrient agar.)
2. Sterilization, inoculation, and incubation of the above media.
3. Using a colorimeter or turbidity tubes to determine the growth curve of *Escherichia coli.*

PROBLEMS

1. What boiling procedure will give most effective sterilization of nutrient broth inoculated with *Bacillus subtilis?*
2. What is the optimum pH *and* temperature for growth of *Serratia marcescens?*

Unit IV. What are microbial nutritional requirements?

TECHNIQUES

1. Preparation of a synthetic basal medium for *Euglena* or *Escherichia coli.* (Includes the use of the chemical balance, adjusting pH, and adding growth factors, trace elements, and chelating agents.)
2. Setting up a complex experiment involving the simultaneous testing of several nutritional factors or concentrations on the growth of a microorganism.
3. Microbiological assay technique.

PROBLEMS

1. To test the effect of nutrients, singly and in groups, on the growth of *Tetrahymena.*
2. To determine the phosphate content of an unknown solution.

Unit V. What products do microorganisms synthesize from their food?

TECHNIQUES

1. Using the radioautograph technique to test the uptake of radiophosphorus by *Bacillus subtilis.*
2. Preparation and inoculation with bacteria and molds of special media such as sugar, nitrate, peptone, and nutrient broths to test for extracellular production of acids, gases, nitrate, ammonia, indole, and catalase.
3. Applying the zone of inhibition technique to determine the production of antibiotics by molds.
4. By paper chromatography, to demonstrate the amino acids synthesized intracellularly by *Escherichia coli.*

PROBLEMS (Choose One)

1. How do *Escherichia coli* and *Bacillus subtilis* compare in uptake of radiophosphorus and radioiodine?
2. Does a mold found in the soil on the school grounds produce an antibiotic?
3. To compare the effectiveness of soaps, dentrifrices, deodorants, antiseptics, disinfectants, or antibiotics on the inhibition of growth of *Bacillus subtilis.*
4. What amino acids are produced by an unknown microorganism?

Unit VI. How are microbial characteristics changed and inherited?

TECHNIQUES

1. Producing mutations artificially. (By using ultraviolet light on *Escherichia coli,* streptomycin on *Euglena,* and increasing antibiotic gradient on nonresistant bacteria.)
2. Demonstrating T3 bacteriophage-sensitivity of *Escherichia coli,* Type B.
3. Replica-plating technique to determine the nature of nutritional mutants (auxotrophs).
4. Recombining traits to show sexuality in *Escherichia coli.*

PROBLEM

To produce a mutant, determine its nature, and prove that it can be inherited.

Unit VII. Term Problems.

(A more complete list is given at the end of this article.)

1. To study microbial succession in plant or soil infusions and determine the possible reasons for the changes.
2. What is the best method of slowing down ciliates for laboratory study?
3. What is the effect of varying the frequency of an electric current on the behavior of a microorganism?
4. Will starvation increase conjugation rate in *Tetrahymena geleii?*
5. Will tranquilizers alter the behavior of *Euglena gracilis?*
6. What is the percentage of mold spores that will germinate?
7. To study the growth curves of a variety of microorganisms.
8. To find the best commercially prepared medium for growth of molds.
9. Will yeast or yeast extract reduce the bactericidal effect of ultraviolet light?
10. Are the minerals in tap water as effective as the addition of a trace element mix, like 45A, in promoting growth of a specific microorganism?
11. Is Asparagine a limiting growth factor of *Euglena gracilis?*
12. Study the effect of an antimetabolite on microbial growth.
13. How much phosphate is present in a unit of frog brain?
14. Does the blue-green alga, *Nostoc muscorum,* fix nitrogen?
15. What is the minimum concentration of penicillin which will inhibit the growth of blue-green algae?
16. To study apochlorosis in *Euglena* using streptomycin or achroflavin.
17. To study auxotroph production in *Neurospora crassa.*
18. Can DNA extracted from one microorganism alter the traits of another?

At first glance the course may appear rather formidable. But remember, it is intended for scientifically gifted high school seniors—perhaps for those who might otherwise elect an advanced placement or seminar-type course in biology. Moreover, many of the units will be found to be amazingly simple while others may be modified to meet class needs. And at the Bronx High School of Science, where the Laboratory Techniques course attracts a random sampling from among the senior class, no difficulties with the units were encountered. In fact, more than thirty sophomores who mastered the techniques went on to win national awards after solution of some of the problems.

Two matters demand clarification: a more detailed account of the techniques and a description of the course as it has actually been offered. By and large, most of the techniques are set forth in a manual such as, *Laboratory Exercises in Microbiology,* by Pelczar and Reid, published by McGraw-Hill Book Company. Additional techniques developed by the writer are recorded in a step-by-step manner and given below. As to the most effective conduct of the course, the experience of the author teaches that one might best adhere to the following procedures:

1. Organize the course into two double laboratory periods on different days in order to provide sufficient time for student performance of the required techniques and problems.
2. Permit students to work in pairs to master the techniques but require

individual effort in the solution of the problems.

3. Call for submission of completed problems in written form as scientific "papers" to be graded.
4. Encourage initiation of term problems as soon as the proper techniques have been grasped.
5. Provide for a fifth period on a third day of the week for seminar discussions.
6. Use the seminar periods to collate all the data gathered on the unit problem and base the discussions upon wide reading as well as individual laboratory findings.
7. At intervals conduct the seminar as a scientific forum for the presentation and defense of the written scientific "papers."

Not for a moment should it be thought that microbiology is the only college-grade course that may be modified according to the plan outlined. No doubt the same can be accomplished for college botany, zoology, genetics, and others. Hence the conclusion seems inescapable: almost the entire field of biology can be so treated. Begin each unit by introducing relevant techniques, follow up with experiences in problem solving and with related readings, and tie the whole presentation together at seminar discussions. For example, why cannot elementary biology open with a unit on getting acquainted with living things, observing their structure and behavior? Within this unit, youngsters could acquire the techniques of collecting, sheltering, feeding, growing, and observing a wide variety of organisms; field trips would be in order. And arising naturally from these experiences would be a series of problems for investigation. Subsequent units could concern themselves with nutrition, physiology, health, reproduction, genetics, ecology, and evolution—all dealt with in a similar manner wherever possible.

But a philosophy consistent with the above thinking is basic; namely, the conviction that biology—and indeed all science—has something unique to impart, something that goes beyond the text, beyond ephemeral content. Just as music and art emphasize their special instruments, techniques, and creative elements, so, too, must science. Let us insist that our science students use their hands and their eyes, do things, solve problems, create—in addition to reading, knowing, and understanding. The potentialities stagger the imagination.

C. M. POMERAT, UNIVERSITY OF TEXAS MEDICAL BRANCH, GALVESTON, TEXAS

Study of the tissue culture of chick embryos shows spinal ganglion cells.

SOME SUGGESTED TERM PROBLEMS

It is required that you choose one or more term problem, write it up scientifically, and submit it for a grade before the end of May. You may choose one of those given below, devise one of your own which is approved, or expand a unit problem which you may or may not have completed earlier.

Unit I. Morphology and Behavior.

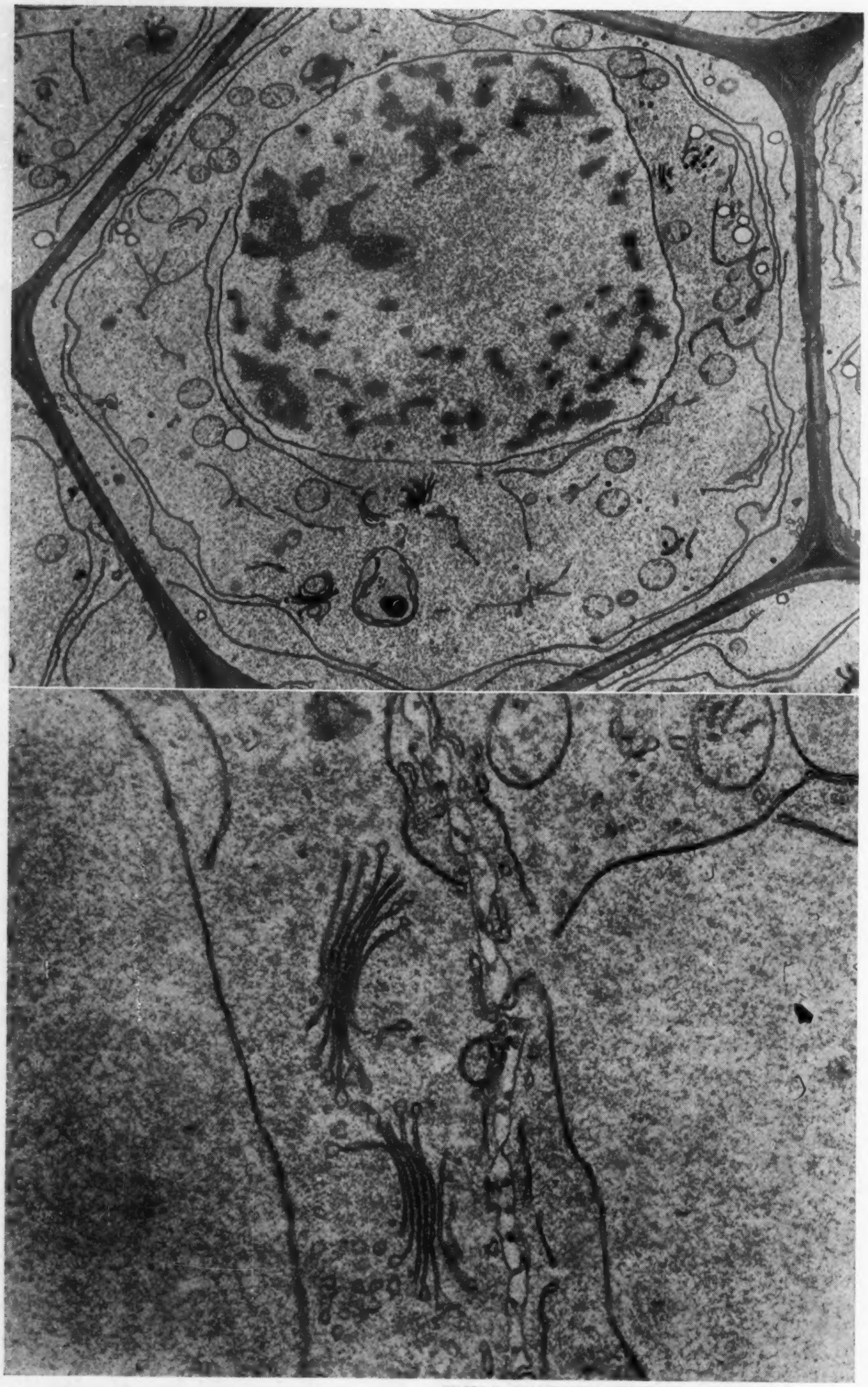
1. Make a slide collection showing various types of flagellar arrangement.
2. Prepare a survey of the spore-forming microorganisms in the air.
3. Present an exhibit of the different cell arrangements of *cocci* and *bacilli.*
4. Survey the microorganisms present in the soil.
5. By means of unstained smears determine a possible relationship between pigment color of colonies and individual cell color.
6. Using smears, determine the percentage of comma-shaped compared with rods in cultures of *Rhodospirillum rubrum.*
7. Compute the length, width, and depth of *bacilli* to determine their volume.
8. Compute the number of *cocci* present in a colony.
9. Make a series of smears demonstrating the presence of inclusion bodies in bacteria.
10. Survey the gram-staining characteristics of a wide variety of bacteria.
11. To make a key for the identification of a large number of known bacteria.
12. To survey the internal organs of a frog in order to ascertain the microbial content.

Unit II. Microorganisms.

13. Accurately count the microorganisms in one cubic foot of air.
14. To determine the bactericidal effects of various means of air purification.
15. To determine the effect of various diets on the bacterial flora of urine.
16. Comparison of the flora at various soil levels.
17. To construct a colony counter and test it.
18. To isolate and identify an unknown mold culture from the soil.

Unit III. Microbial Growth.

19. To determine by many observations the accurate growth curve of a microorganism.
20. Compare growth rates of *cocci, bacilli,* and *spirilli.*


HILTON H. MOLLENHAUER, UNIVERSITY OF TEXAS, AUSTIN, TEXAS

Micrograph of organisms found in plant roots disclose complicated structure of cell walls.

21. Determine accurately the minimum, maximum, and optimum temperatures of various microbes.
22. To find accurately the pH range of different microorganisms.
23. Ascertain minimum lethal dosage of various compounds for specific microorganisms.
24. Develop pure cultures of psychrophilic and thermophilic organisms.
25. To find the mathematical relationship between distance or time of ultraviolet exposure and number of bacteria killed.
26. Develop, by varying conditions such as temperature, different colored strains of chromogens and determine whether the change is inherited.
27. By lyophilization, preserve specific organisms for long periods of time.
28. Find the effect of various colors of visible light on bacterial growth.
29. Determine the effect of Eosin on a variety of bacteria as a sensitizer to ultraviolet or visible light.

Unit IV. Microbial Nutrition.

30. Devise a synthetic medium and test its effect on growth of a microorganism.
31. Remove various nutrients from a known synthetic medium and test the effects on the growth of a specific microorganism.
32. Modify a poor medium to increase its efficiency with regard to a specific microorganism.
33. Construct a colorimeter and test it.
34. Devise a medium for selectively growing molds.
35. Make microphotographs of the stages of growth of a mold spore.
36. Determine the effect of various substances on germination of spores.

Unit V. Microbial Biosynthesis.

37. Develop an antibiotic from microorganisms in the soil.
38. Determine the pigments present in a chromogen.
39. Find the antibacterial effect of a microbial pigment.
40. Effect of antibiotics on psychrophilic and thermophilic bacteria.
41. Determine the possible relationship between chromogenic color and amino acid production or absorption.
42. Describe completely the physiological characteristics of a known microorganism.
43. To identify by genus and species an unknown microorganism.
44. To determine the amino acids produced by a microorganism when grown in different media.
45. By microscopic radioautograph technique to find the parts of a microbe that absorb radiophosphorus.
46. By chromatography to identify an unknown antibiotic.
47. To separate an antibiotic in relatively pure form from its substrate.

Unit VI. Microbial Genetics.

48. To build highly resistant strains to an antibiotic.
49. To change resistant strains of microorganisms to susceptible form by mutations.
50. To develop a strain of microorganism resistant to many antibiotics, antiseptics, or disinfectants.
51. To make a collection of chromogenic mutants.
52. To find the effect of chemical and physical conditions on the activity of bacteriophage.
53. To build phage-resistance in host microorganisms.

SOME MICROBIOLOGICAL TECHNIQUES

From Unit II. Location of Microbes.

Purpose

To solve various problems using the pour plate method: hardened agar techniques.

Method

1. Melt a sterile nutrient agar butt (test tube ½ full of dehydrated nutrient agar) in a water bath. Have the water in the beaker boil for several minutes to be sure the agar has melted completely.
2. Cool the agar to about 45°C, or to a temperature cool enough to hold comfortably in the hand.
3. Pour the melted agar into a sterile Petri dish and rotate to distribute the agar evenly over the entire surface.
4. Allow the agar to harden.
5. Introduce the bacteria in some miscellaneous experiments:
   a. For Air: simply remove Petri dish cover, expose to air for 20 minutes and replace cover.
   b. For Aerosols: spray air first, then expose.
   c. For Ultraviolet Light: soak a sterile cotton swab into a broth culture of *Serratia marcescens*. Then, inoculate the agar surface of several plates evenly. Do *not* dig into agar. Keeping one plate as a control, remove the covers of the remaining plates and expose them to ultraviolet light for periods ranging from 2 to 20 minutes. Replace covers.
   d. For Urine: swab urine evenly over agar surface.
   e. For Dentures: using a toothpick, scrape tartar from between teeth before and after brushing. Streak on agar surface in four quadrants.
6. Invert plates and incubate 24 to 48 hours.

Purpose

To solve problems by means of the serial dilution and counting technique.

Method

1. Prepare the sample carefully as described below:
   a. Weigh out 0.5 g of food or soil.
   b. Measure out 0.5 ml of water.
   c. For Milk: warm the milk to about 60°C, and shake thoroughly. Keep warm for 30 minutes, then cool rapidly under running water. Use ½ ml.
2. Prepare dilutions by following the steps below:
   a. Set up 4 small test tubes each with 4½ ml sterile water.
   b. Add ½ g or ½ ml to test tube No. 1. Shake thoroughly or use pipette to mix (1:10 dilution).
   c. For 1:100 dilution, take ½ ml of tube No. 1 suspension, add to tube No. 2 and shake thoroughly.
   d. Repeat in tubes Nos. 3 and 4 for dilutions of 1:1000 and 1:10,000.
   e. Soil and milk should be diluted up to 1:1000, water to 1:100, and food to 1:10,000.
3. Plate out *each dilution to be counted* as follows:
   a. Place 1 ml of dilution in sterile Petri dish.
   b. Pour melted agar butt, *at 45°C,* over the diluted suspension.
   c. Rotate Petri dish to mix thoroughly.
   d. Allow to harden and incubate for 24 to 48 hours.

From Unit III. Microbial Growth.

Purpose

To determine the growth curve of *Escherichia coli.*

Method

1. Prepare two test tubes filled with 10 ml of nutrient broth.
2. Sterilize in autoclave at 15 pounds for 15 minutes.
3. Inoculate one test tube, using sterile precautions, with 0.2 ml of *Escherichia coli* in nutrient broth suspension.
4. Leave the other test tube uninoculated as a control.
5. Incubate both test tubes at 37°C.
6. Take periodic readings of both tubes in the colorimeter as follows:
   a. Place the control in the colorimeter and set the device at zero accurately.
   b. Remove the control and replace with the *Escherichia coli* inoculated tube.
   c. Take reading and record it.
   d. Continue taking both readings at as frequent intervals as possible for at least 24 hours.
   e. Make a graph of your findings.

From Unit V. Microbial Biosynthesis.

Purpose

To make radioautographs of bacteria.

Method

1. Introduce 0.5 microcurie of radiophosphorus into a sterile Petri dish.
2. Melt an agar butt, cool to 45 to 48°C, and pour into the Petri dish.
3. Rotate Petri dish to mix the agar and the radiophosphorus thoroughly.
4. Allow agar to harden.
5. Streak the plate with the test organism. You may use either *Escherichia coli, Bacillus subtilis,* or any other available bacterium. It is often effective to

Use of the electron micrograph gives vivid portrayal of microorganisms. (Coxsackie Virus A-10 with magnification about 7300X.)

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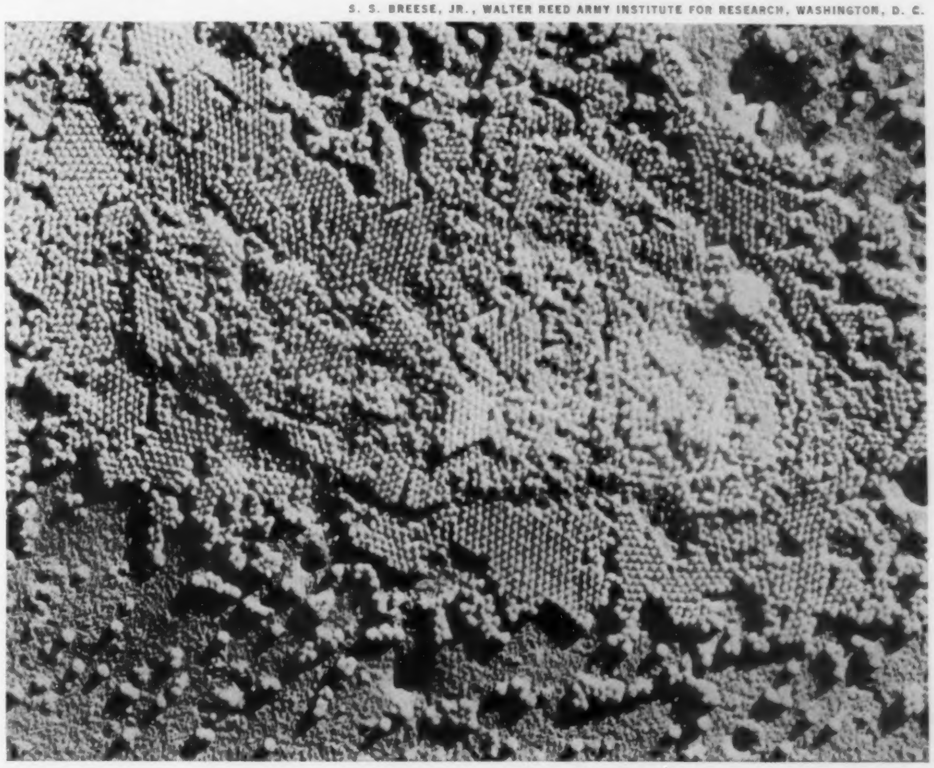


make two similar line streaks of two organisms for comparative purposes. You may streak by making interesting designs.

6. Incubate for 24 to 48 hours.

7. Cut out Saran Wrap, cellophane, or wax paper in the form of the inside of the Petri dish. Press the paper on the streak with gentle action of the fingers being careful not to dig into the agar.

8. Remove paper to which the bacteria have adhered. Dry in sunlight or use a lamp.

9. Determine the percentage of radioactivity absorbed by the bacteria as follows:

a. Take a background reading on a Geiger counter.
b. Take a reading of bacteria in the Petri dish.
c. Take a reading of the bacteria alone on the wax paper.
d. Compute the fraction and per cent of activity absorbed.

10. If you wish to make a radioautograph do the following with the aid of your instructor:

a. Place paper in the center of film holder with Scotch tape. Expose to no-screen X-ray film for two days to a week.
b. Develop in D-19 developer for 4 to 6 minutes.
c. Print picture on contact paper, if you wish.

Purpose

To demonstrate the production of various amino acids by bacteria.

Method

1. Inoculate 10 ml of sterile nutrient broth in a test tube with *Bacillus subtilis, Escherichia coli,* or any other available bacterium.

2. Incubate for 24 to 48 hours.

3. Centrifuge the medium for 15 minutes.

4. Decant, throwing supernatant fluid down the drain.

5. Resuspend solid material (the bacteria) in 2 ml of distilled water. Use pipette or Pasteur pipette to mix the solid matter and water thoroughly.

6. Pour the medium into a test tube (preferably a large one). Mark depth with colored pencil.

7. Boil in water bath for 20 minutes, keeping the volume at the same depth by adding distilled water as needed.

8. Centrifuge, decant, and *save supernatant.*

9. Make chromatogram using the supernatant to test for the presence of specific amino acids.

a. Obtain a long strip of Whatman No. 1 filter paper.
b. Using a loop, place the supernatant drop-by-drop on a line ruled in *pencil* about one inch from bottom of the paper. Wait for each drop to dry before placing the next drop on top of it. You may need about 15 drops.
c. Suspend strip of filter paper so that the bottom end touches the solvent in a long battery jar. (Solvent is composed of 20 ml glacial acetic acid, 20 ml distilled water, and 80 ml of butanol.)
d. Cover battery jar tightly and leave for 18 to 24 hours.
e. Remove strip, air dry, and spray with 0.5 per cent ninhydrin solution (66 ml).
f. Dry in hood after ruling a line representing the highest distance the solvent has traveled.
g. Compute the R_f for each spot obtained by getting the ratio of the highest distance the spot (amino acid) traveled to the greatest distance the solvent traveled.
h. Consult chart to determine the name of each amino acid produced by *Escherichia coli.*

Purpose

To solve problems with the zone of inhibition technique.

Method

1. Melt an agar butt in a water bath and cool to 45°C.

2. Inoculate by adding two loops of the bacterial culture to be tested to the melted agar.

3. Mix thoroughly by rolling tube between the palms of the hands.

4. Pour the melted agar into a sterile Petri dish and allow the agar to harden.

5. Using a wax marking pencil, divide the bottom of the lower Petri dish into the number of sections to be tested.

6. Using flame-sterilized forceps saturate separate filter paper disks with each of the materials to be tested. Be sure to allow the excess of the liquid material to drip back down the side of the bottle.

7. With the sterile forceps, place each disk into the center of each section of the agar outlined. Have the disk make firm contact with the agar by *gently* pressing it down with the flat of the forceps. Sterilize the forceps before applying each disk. At the center of the agar in the Petri dish place a control disk with distilled water. You have done this section correctly if each test disk is equidistant from the center of the plate and the edge and if the disks are equidistant from one another.

8. Invert the Petri dish and incubate for 24 to 48 hours.

9. At the termination of the incubation time compare the sizes of the inhibition zones by measuring from the disk to the edge of the zone with a ruler. The metric system is best used for accuracy.

From Unit VI. Microbial Genetics.

Purpose

To show lysis and plaque formation of T3 bacteriophage on its host organism, *Escherichia coli,* Type B.

Method

1. You will receive two small 3-inch test tubes; the clear one contains 0.6 ml of phage, the cloudy one, 1 ml of *coli.*

2. Introduce 0.5 ml of *Escherichia coli* into a sterile plastic Petri dish by means of a sterile pipette. If the pipette is unavailable, simply mark off half the amount of *coli* given and pour into the Petri dish, observing sterile precautions.

3. Using a water bath, melt a sterile agar butt and cool about 45 to 48°C. If the test tube of melted agar can be held comfortably in the hand, it is probably at about the right temperature.

4. Pour the melted agar into the Petri dish observing sterile techniques.

5. Mix the *Escherichia coli* and agar thoroughly by rotating the plate and by moving it back and forth.

6. Allow the agar to harden.

7. Using a sterile loop, take a loopful of T3 phage from the second (clear) test tube. Streak the phage on the surface of the agar being careful not to break or dig into the agar.

8. The streaks should be made in three sections, flaming the needle between each section and making each section about three or four strokes wide.

9. Incubate at 37°C for about 6 to 12 hours. Observe.

10. After the lysis has been observed as clear areas in a grey background, and the plaques as clear circles in the same background, the plates should be kept under refrigeration.

Purpose

To produce resistant strains of *Escherichia coli,* Type B, to T3 bacteriophage.

Method

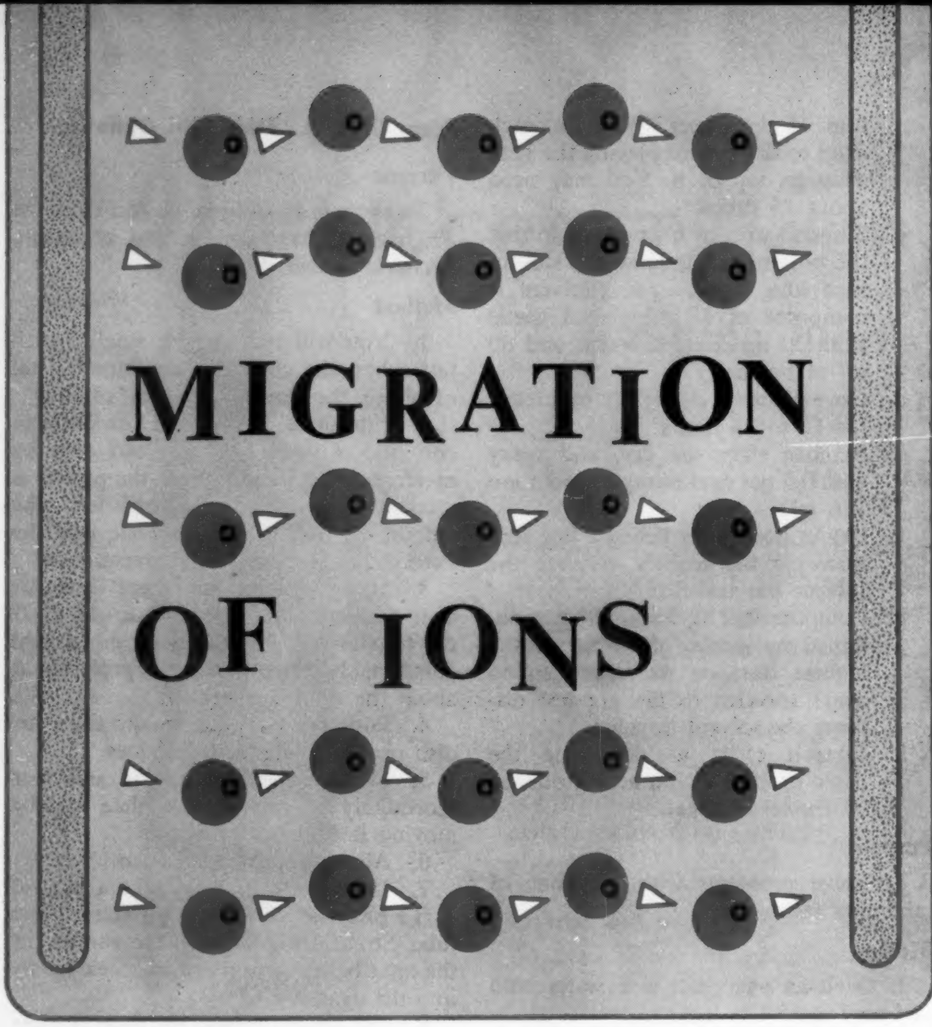
1. Introduce 0.5 ml of *Escherichia coli* into sterile Petri dish. You may use the half of the *coli* left over from the previous experiment. Use sterile precautions.

2. Repeat numbers 3, 4, and 5 above and allow this Petri dish to harden.

3. Pour the remaining phage on the hardened agar using sterile methods.

4. Spread the phage over the surface of the agar evenly with a bent glass rod which has been dipped in alcohol several times and burned. It is essential that the rod be sterilized or contaminators will be introduced.

5. Incubate for three days at 37°C and observe for pinpoint colonies. These are resistant strains which can be cultures on agar slants.



MIGRATION OF IONS

By WILLIAM N. NICHOLS

Head, Science Department, Vermont College, Montpelier, Vermont

A. DEMONSTRATION USING A SOLID.

THIS DEMONSTRATION shows that ions will migrate not only in an aqueous solution but also in a molten substance, in a seemingly solid one (actually a supercooled liquid) such as glass, and in a gas. It is a spectacular demonstration from the viewpoint of the student, since it shows a metallic deposit forming on the inside of a light bulb while the bulb is in operation. Few demonstrations have proved so effective in stimulating student interest in scientific research, and because of this, I found it worthwhile to investigate its possibilities more fully.

My investigations led to the following:

1. Several modifications of the older methods.

NOTE: The original demonstration to show this phenomenon of ionic migration dates back to sometime before 1930.

a. Substitution of 6-volt direct current for 120-volt current, thus making it possible to operate on a simple battery.

b. Substitution of a common graphite electrode for the nickel electrode commonly employed.

c. Substitution of a much more effective sodium nitrate-sodium nitrite mixture for the commonly used sodium nitrate. This mixture has a much lower melting point than sodium nitrate and gives a much more effective anode reaction.

d. Substitution of a small 15-watt clear glass night-light bulb for the larger 60-watt bulb commonly used. This smaller bulb makes research projects much easier as it facilitates analytical weighing and also allows the demonstration to be carried out with a much smaller amount of molten mixture.

2. Several suggested avenues of research.

a. Did the sodium ions pass through the glass or were sodium ions in the glass displaced by sodium ions from the molten mixture?

b. Is the molten deposit sodium?

c. How do you know that the sodium comes from outside the glass bulb?

d. What is the reaction taking place at the anode?

e. What takes place at the cathode?

f. Possible use as a photoelectric cell.[1]

g. Microscopical qualitative analysis-methods for sodium.[2]

h. A study of electrode potentials.

i. Melting points of mixtures.

j. Have any changes taken place in the composition or in the appearance of the glass?

k. Have any changes taken place in the composition or in the appearance of the filament?

l. Spectrum analysis.

Procedure

1. On a large piece of filter paper place 30 g of sodium nitrate and 30 g of sodium nitrite, and thoroughly mix with a spatula.[3] Transfer the mixture to a 100-ml beaker supported on an asbestos-centered wire gauze over a Bunsen burner.

2. Obtain a small 110-volt, 15-watt night-light bulb, and support it on the same ring stand that holds the salt mixture in such position that it can be lowered into and raised out of the mixture easily. Connect one end of a convenient length of copper wire to the filament of the bulb, and connect the other end to the negative pole of a 6-volt storage battery. Melt the salt solution and adjust the flame so that the mixture remains in the fluid state. Support a graphite rod on another ring stand and place the stand so that the graphite rod dips into the molten mixture. Connect the graphite rod to the positive terminal of the 6-volt battery and lower the bulb into the mixture so that a portion of the filament is beneath the surface. Light the bulb. (See Figure 1.)

The sodium ions migrate through the glass, through the gaseous medium inside the bulb, and to the hot filament.

[1] Richard M. Sutton. *Demonstration Experiments in Physics*. McGraw-Hill Book Company, Inc., New York. 1938. p. 337.

[2] Chamot and Mason. *Handbook of Chemical Microscopy*. Volume II. John Wiley and Sons, Inc., New York. p. 52-8.

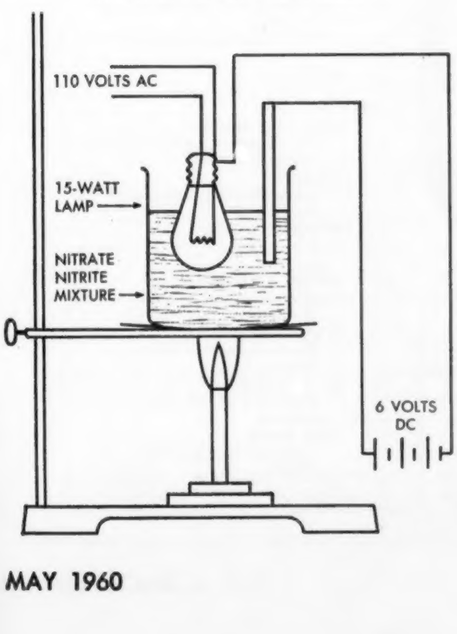
[3] The melting point of sodium nitrate is 310°C. That of sodium nitrite is 271°C. That of the mixture is approximately 225°C.

The positive sodium ions are there reduced to sodium atoms, which plate out on the upper, cooler part of the bulb. A good mirror is obtained in 20 to 30 minutes.

Suggested Student Project

1. Obtain a 15-watt clear glass night-light bulb.
2. Wash the bulb with water and wipe it dry with a clean towel. Weigh the bulb to constant weight on an analytical balance. Record the weight of the bulb. Carry out the plating following the procedure outlined above for two hours. Remove the bulb from the molten mixture and allow it to cool. Wash the bulb with water, dry it with a clean towel, and weigh to a constant weight. Record the weight and compare it with the weight before plating.
3. Make a deep scratch with a file approximately ¼ inch from the tip of the bulb. Heat an iron rod (⅛″ to ¼″ in diameter) and place it in the scratch. The glass will crack in a circular direction around the bulb. Follow the crack with the hot rod, heating the rod when necessary. In a short time the crack will extend completely around the bulb and the head of the bulb will drop off.
4. As soon as the top of the bulb is removed, place 5 to 6 drops of water **(caution)** in the bulb. Note signs of vigorous reaction. Test the solution with litmus paper. What metals, when placed in water, will give this test? Pour the solution onto a watch glass and apply the flame test.
5. Recommend and carry out other qualitative tests for sodium.

FIGURE 1.
Apparatus for use with a solid.



Author observes reaction of ions in solid.

B. DEMONSTRATION USING A SOLUTION

DEMONSTRATIONS COMMONLY used to show this phenomenon usually employ a U tube containing a variety of gelatinous suspensions of colored ions superimposed with a gelatinous suspension of a colorless electrolyte. These demonstrations are all good but are time consuming to prepare and very often fail to show a clear-cut separation of colored ions during a regular class period. In this revised demonstration, I have devised a method which is extremely simple to set up and always gives a clear separation of colored ions that is visible to all students within the time limits of a regular class period. Usually migration will be visible within five minutes. The white cotton roll salt bridge serves not only as a simple yet excellent medium for the migration of the ions but also gives an excellent white background for viewing the separation of colors.

Preparation

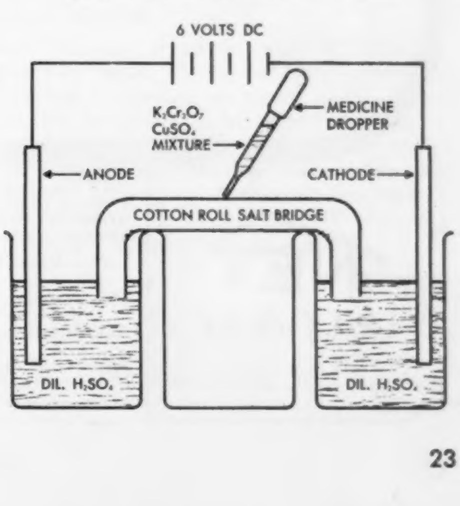
1. Prepare 200 ml of N copper sulfate and 200 ml of N potassium dichromate. Note the color of the solutions.
2. Mix 75 ml of the N copper sulfate solution with 75 ml of the N potassium dichromate solution and add a few drops of dilute sulfuric acid to prevent hydrolysis. Note the color of the mixture.
3. Prepare 200 ml of 0.1 M sulfuric acid.
4. Obtain a Johnson & Johnson absorbent cotton roll No. 2, 6″ x ⅜″.[4]

Procedure

1. Arrange three 100-ml beakers in a row and fill the two end beakers three-fourths full of dilute sulfuric acid.

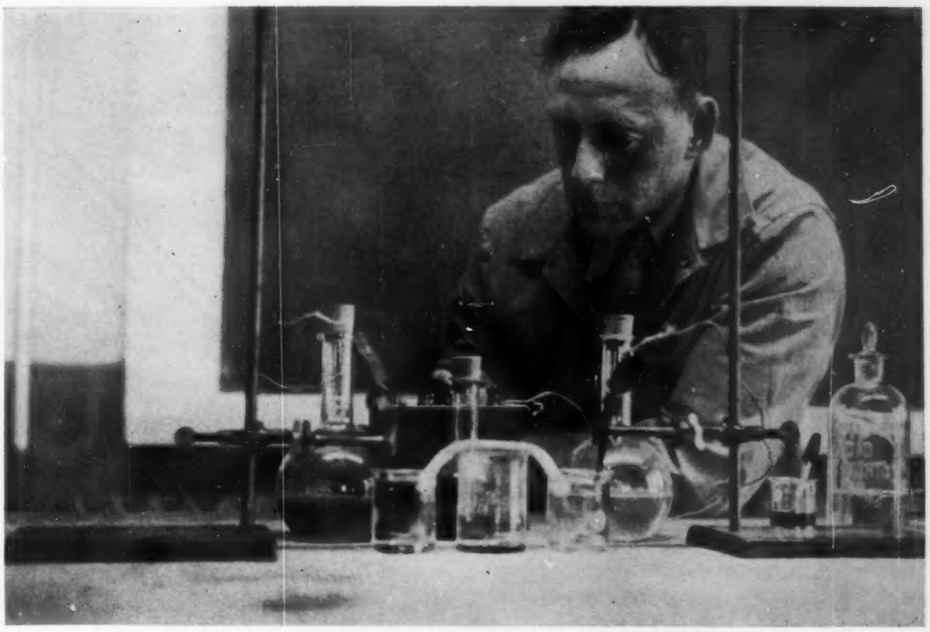
[4] Johnson & Johnson absorbent cotton rolls No. 2, 6″ x ⅜″, may be obtained from any dentist or dentist supply house. Many drug stores also carry them. Besides serving as an excellent salt bridge, these rolls find many other uses in the laboratory.

FIGURE 2.
Apparatus used with aqueous solution.



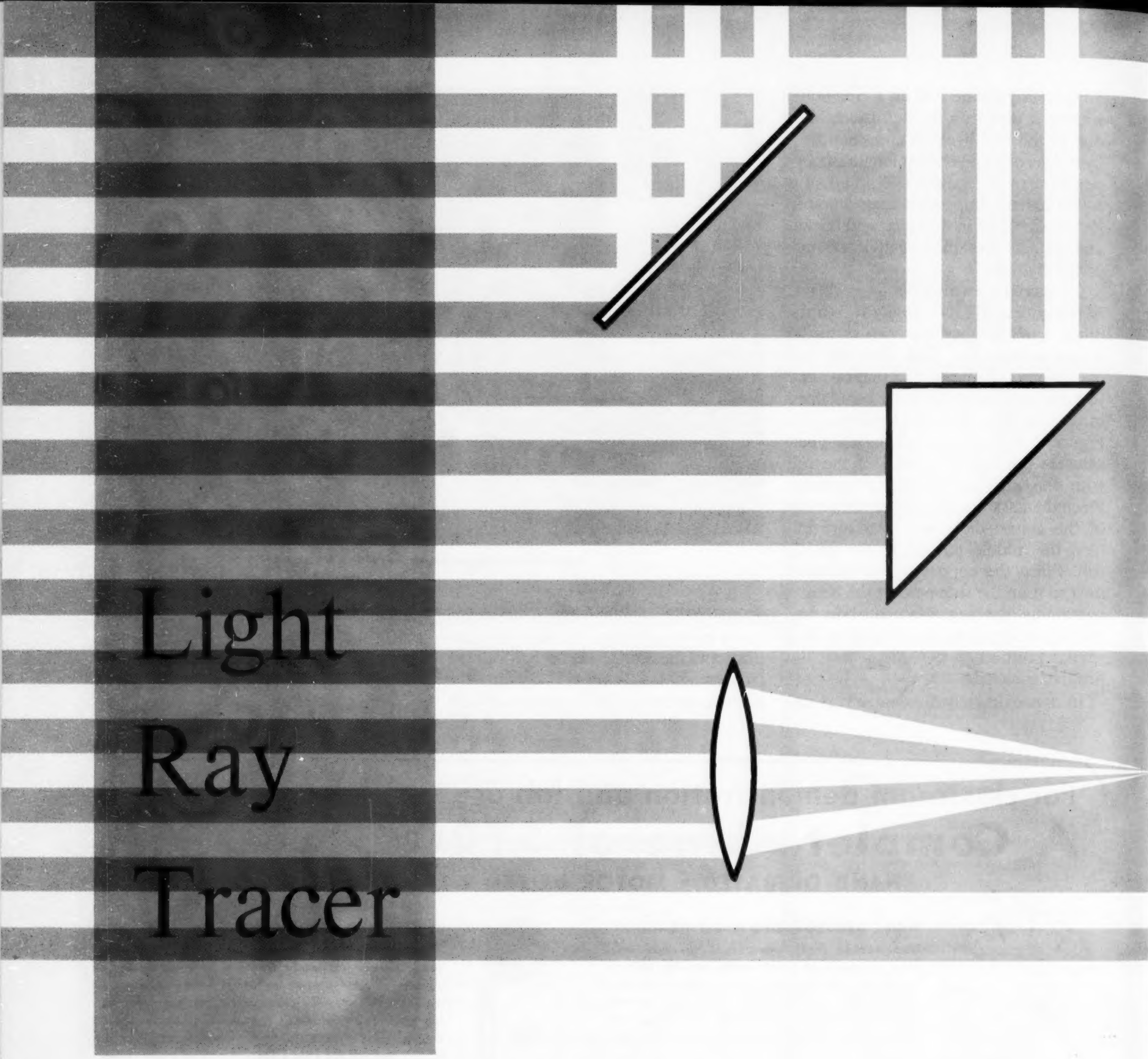
Support a graphite rod on a ring stand so that it dips into the sulfuric acid in one of the end beakers and connect it by means of a convenient length of copper wire to the positive terminal of a 6-volt battery. Support a second graphite rod similarly in the other end beaker and connect it to the negative terminal of the battery.

2. Saturate two inches at each end of the cotton roll by dipping it into the dilute sulfuric acid. Leave the center 2-inch portion dry. Now place the roll over the middle beaker so that one end just dips into the sulfuric acid contained in each of the other two beakers. (See Figure 2.) Using a medicine dropper, saturate the center portion of the roll with the cupric dichromate mixture. Place the flask containing the remainder of the cupric dichromate mixture behind the middle portion of the cotton roll. Place the copper sulfate solution next to it on the side nearest the beaker containing the negative electrode and the potassium dichromate solution in a similar position on the side nearest the positive electrode.



Author checks apparatus for use with a solution.

In approximately 5 minutes it is observed that the blue color of the cupric ion is moving toward the negative electrode and the orange-yellow color of the dichromate ion is moving toward the positive electrode. In approximately 20 minutes a complete separation of the colors may be observed. A color comparison may be made between the different sections of the cotton roll and the solutions placed behind it.



Light Ray Tracer

By STANLEY C. PEARSON

Science Supervisor, Pasadena City Schools, Pasadena, California

REFLECTION and refraction of light rays are commonly demonstrated by using a set of equipment known as the optical disk. A new method of doing the same demonstration can be made available to any teacher at a nominal cost. In general the items required are easily obtainable and consist of a 2″ x 2″ slide projector, simple optical pieces, and a cardboard for use as a screen.

Typically, the component parts of the demonstration equipment are set up so that near parallel rays of incident light strike a piece of optical equipment, such as a lens, and the resulting effect on the rays due to the optical piece is clearly visible to a group as large as two hundred. The relative position between the projector and the special screen is shown in Figure 1. The screen portrayed is made from ordinary shipping carton material and painted with white poster paint. Five holes were cut into it for the placement of the different pieces of optical equipment. Note that the screen and the projector are placed in front of the viewers. The projector, however, is about six feet to the right and ever so slightly forward so that the rays of light strike the screen at a glancing angle. The rays are usually focused sharply at the center of the screen and the projector is placed on

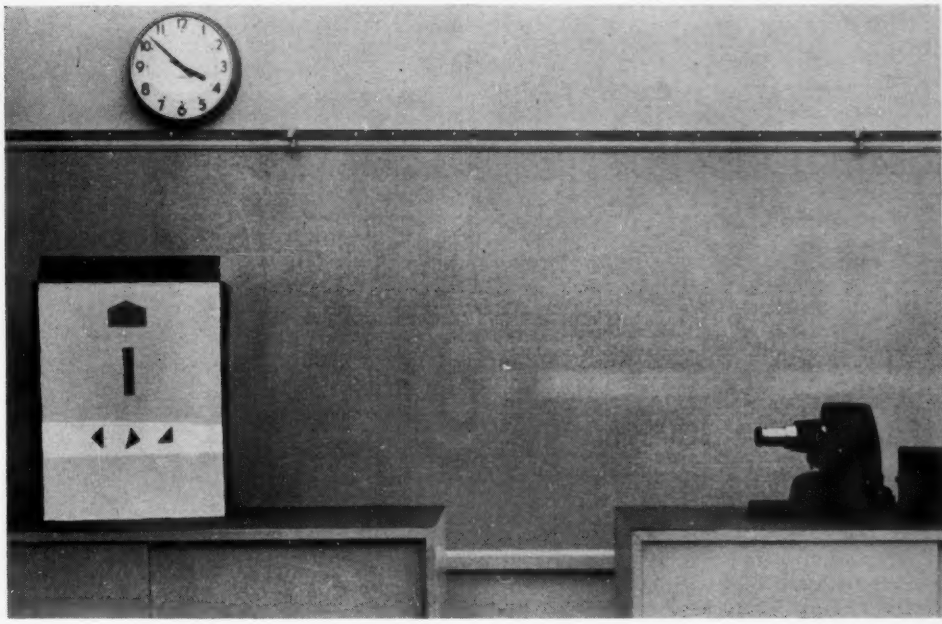


FIGURE 1. General relationship between the two large parts of the apparatus, the screen, and the 2″ x 2″ slide projector.

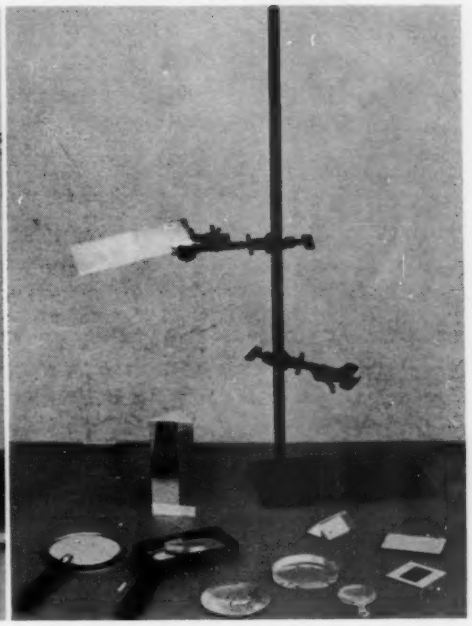


FIGURE 2. Optical equipment used in the demonstration.

its cover when using the upper holes in the screen.

The optical equipment used for demonstrations of reflection and refraction is pictured in Figure 2—lenses, double convex and double concave; a concave-convex mirror; a plane mirror; prisms of glass or lucite; and different angles. Additional items include a 2″ x 2″ slide for projecting the rays and a ring stand with clamps for holding the optics in some of the demonstrations.

The screen and the 2″ x 2″ slide are the only parts of the apparatus which are not readily available and must be made. Fortunately this is not a difficult task. A study of the back of the screen (Figure 3) reveals the simplicity with which a large piece of cardboard can be made into a screen.

The slide for producing the rays of projected light can be made in many ways. Both a mechanical and a photographic method are given. Using a ruling pen and India ink, an area about ¼″ x 1″ is ruled with fine lines closely spaced on a piece of frosted acetate. This is placed in a slide mount and the unruled area is blacked out with poster paint or construction paper. In the photographic method, make a grid with ½-inch black bias tape secured by Scotch tape on a white background and

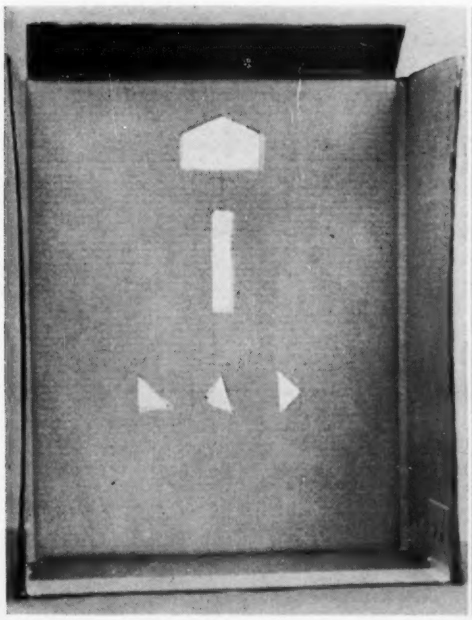


FIGURE 3. Back view of the special screen. When the paper fasteners are put through the bottom crosspiece, screen will stand without further support. Weights of some kind placed on the crosspiece help to keep the screen from moving. Poster paint (white with black trim) is used to finish the front of the screen.

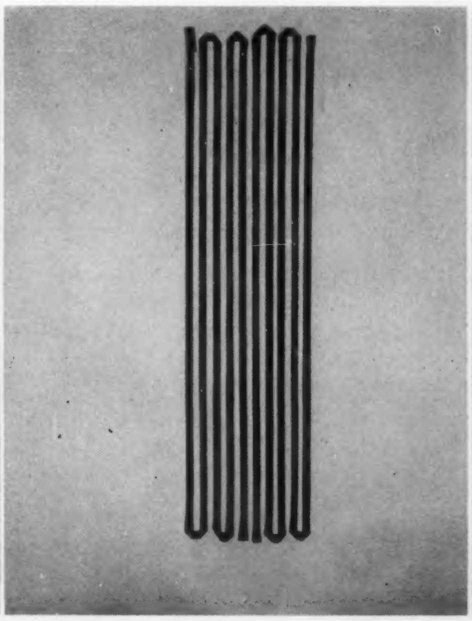


FIGURE 4. Method of applying black bias tape to white background. When photographed the negative is used horizontally in slide projector as a multiple slit source for producing parallel rays.

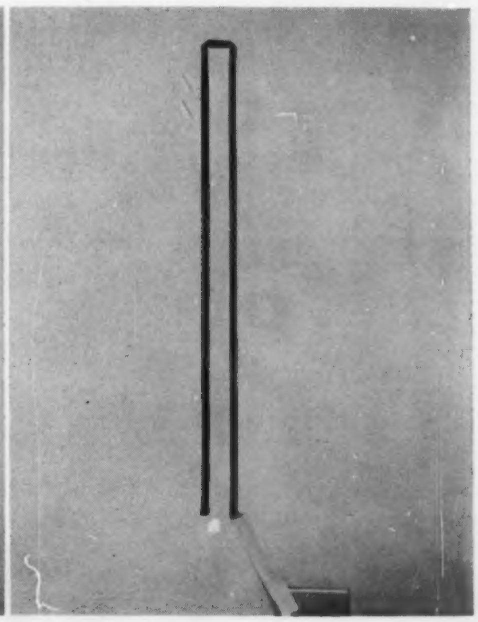


FIGURE 5. Arrangement of black bias tape for a pair of parallel rays.

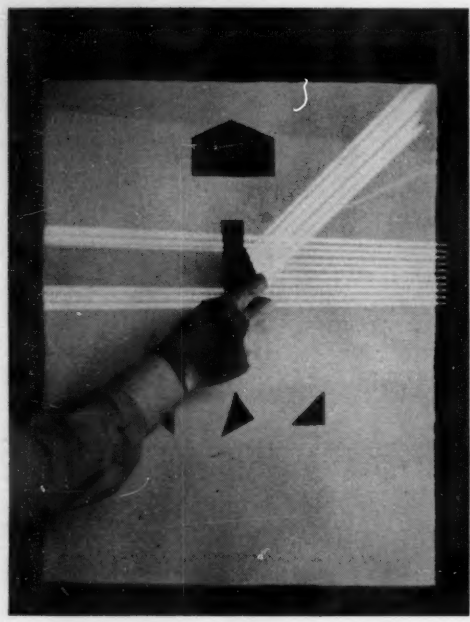


FIGURE 6. Reflection from a plane surface is accomplished by placing a small silvered glass mirror in the rectangular opening. The angle of incidence may be changed by rotating the mirror. If greater angles of incidence are desired, the mirror should be placed in pentagonal opening or at left edge as is done in Figure 11. In general, the projector should be focused so that the rays appear sharp at the place where the optical equipment is to interrupt the rays.

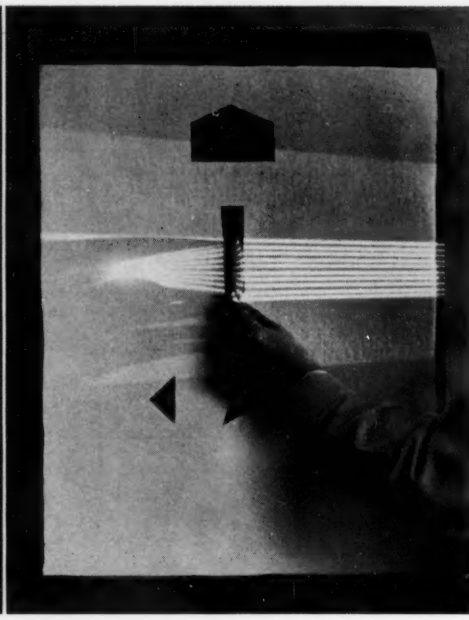


FIGURE 7. A double convex lens placed in the rectangular opening to show the focal point.

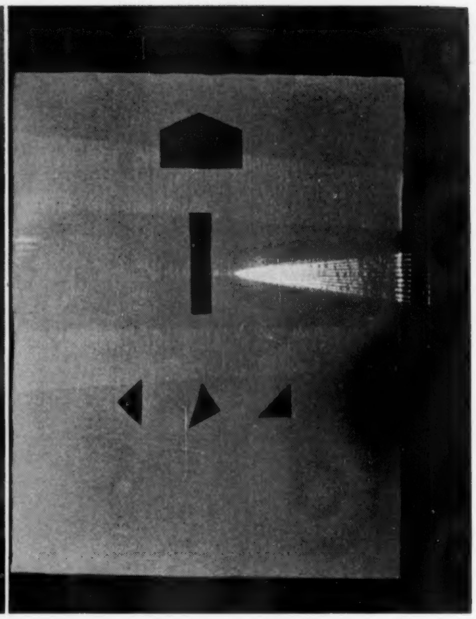


FIGURE 8. A magnifying glass with a handle is used to illustrate the same situation as in Figure 7. In this case the rays are focused on the right edge of the screen.

photograph it with a 35-mm camera from a distance of 7 to 8 feet. (See Figures 4 and 5.)

The tracing of light rays from the simplest concept of reflection from the surface of a plane mirror to the more complex idea of the angle of minimum deviation associated with a prism is clearly portrayed in the photographic illustrations Figures 6 through 17.

Some of the desirable features of the light-tracing apparatus should be emphasized. The light rays are so brilliant that the demonstrations are quite visible without room darkening. If the room is darkened, the added contrast makes the demonstration really spectacular. Specially constructed or sectional pieces of optics are not needed for the commonly available lenses; mirrors and prisms can be placed directly into the beam of parallel rays of light to note the results. If colored light rays are desired they can be produced by using color filters in conjunction with the ray-producing slide. It is possible to conduct the dem-

FIGURE 9. Diverging rays caused by a double concave lens. The lens is placed at the right edge because in this position it is large enough to intercept all the rays and thus prevent any of the incident rays from passing over the edge of lens to disturb the diverging ray pattern.

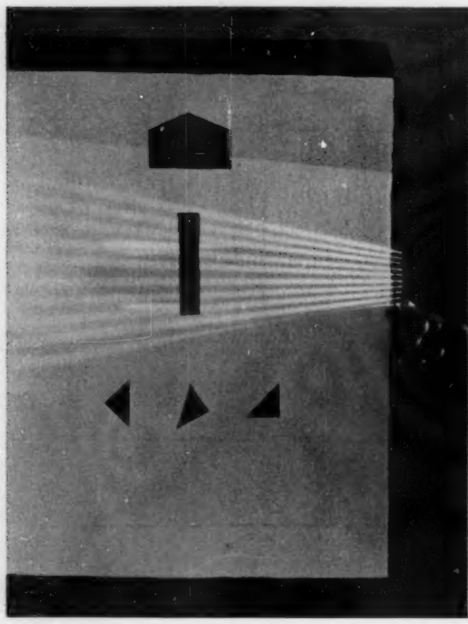


FIGURE 10. Diverging rays reflected from a convex spherical mirror.

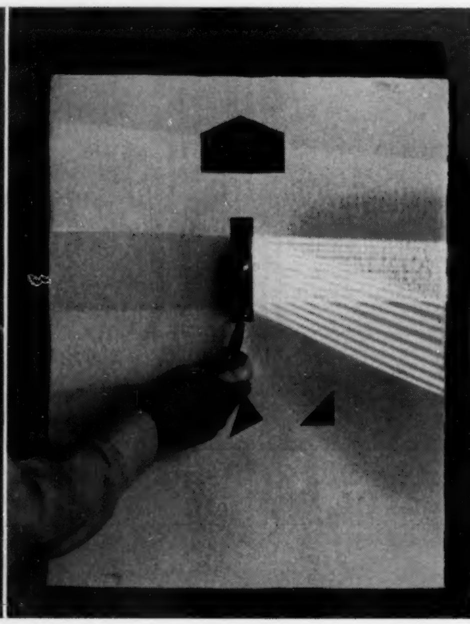
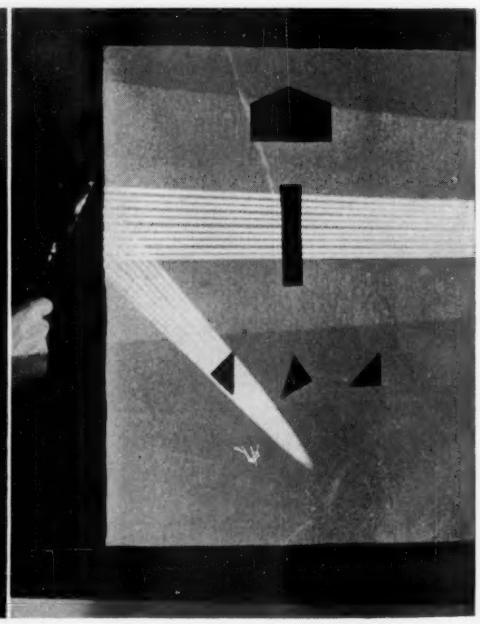


FIGURE 11. The focusing of rays by reflection from a concave spherical mirror.



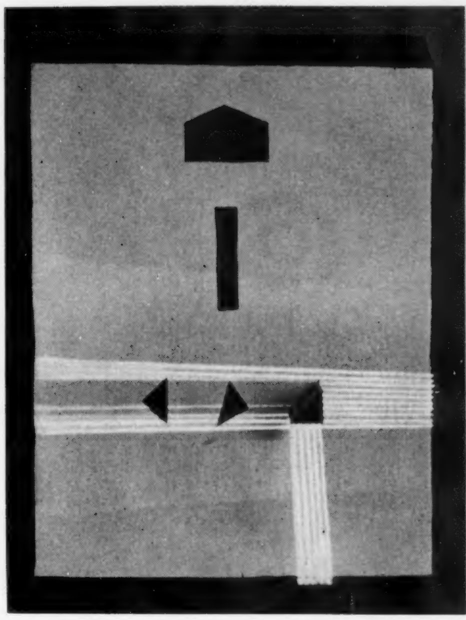


FIGURE 12. A 45°-45°-90° prism placed in right triangular opening illustrates total internal reflection. Note that the incident rays now pass horizontally over the lower openings as the projector cover has been removed from under the projector.

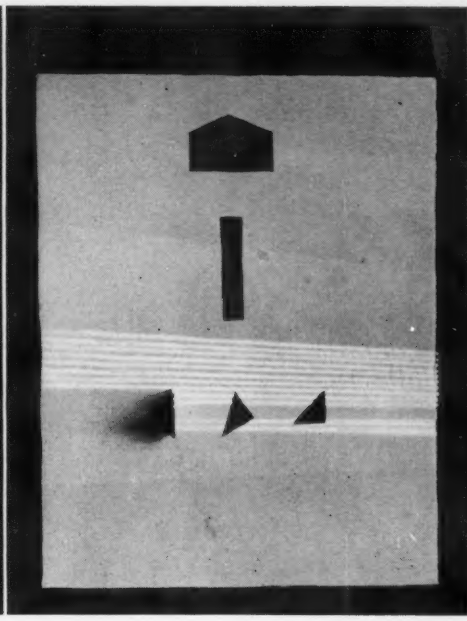


FIGURE 13. A 45°-45°-90° prism in the left opening shows the double internal reflection of a Porro prism.

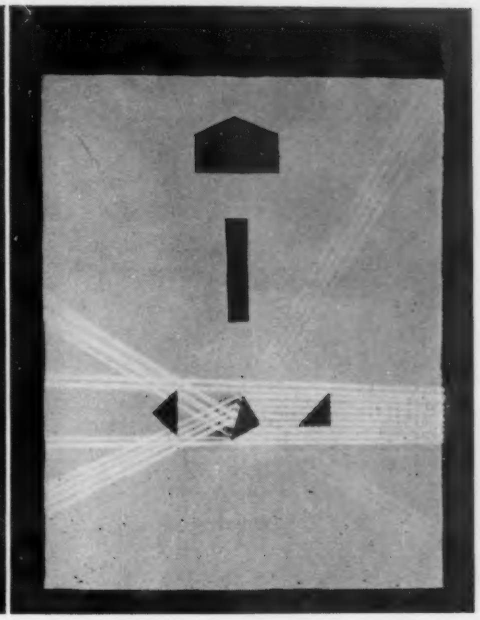


FIGURE 14. The prism in the center opening clearly shows refracted rays. Also visible are other rays illustrating partial external and internal surface reflections. By using a small card to block off the incoming rays, first from the top and then from the bottom, a better understanding of the situation is possible.

onstrations with the demonstrator either in front of or behind the screen. Because of the nature of the equipment and the ease and simplicity of operation it is quite likely that some demonstrations are appropriate for the elementary grades.

In the event that quantitative results are desired, paper can be attached to the screen by masking tape and the rays traced with pencil marks. The paper is then removed and the angles and distances may be measured and studied.

Another interesting experiment with this apparatus concerns cylindrical liquid lenses. Test tubes or cylindrical bottles are filled with water, carbon bisulfide, or other liquids, placed in the beam of parallel light rays, and the variations between the effects noted. Other experiments, demonstrations, or improvements of the "light-ray tracing device" will occur to the user as he becomes familiar with it.

FIGURE 15. A double ray source replaces the multiple ray slide in the projector. A 60°-lucite prism is placed in the path of upper ray so as to deviate it. Angle of deviation is seen at left. If the prism is rotated around the top apex, it will be noted that the angle of deviation decreases until a minimum is reached. The room lighting is high so that method of holding the prism is apparent; hence the rays are barely visible.

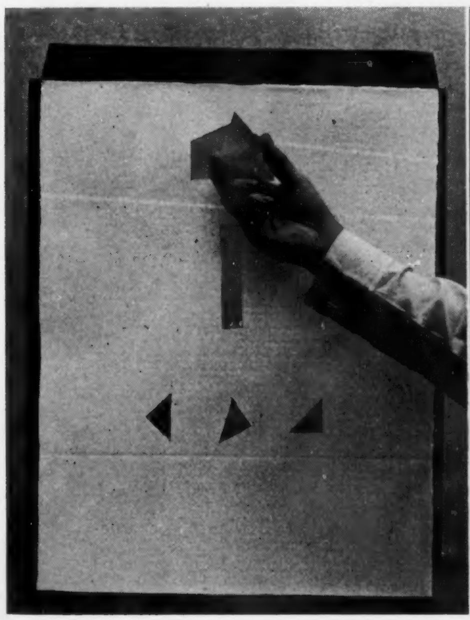


FIGURE 16. A 45° prism deviates the upper ray.

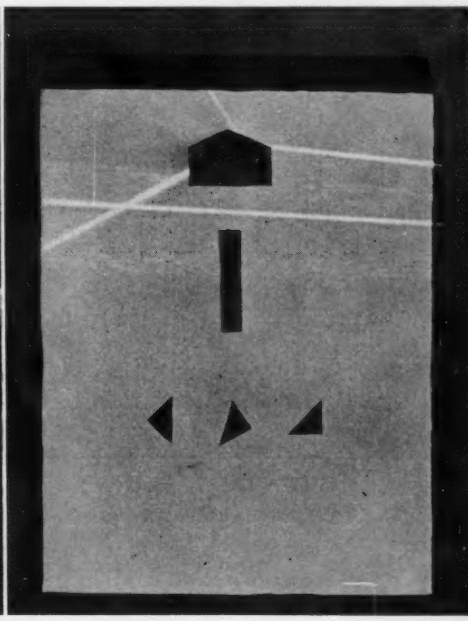
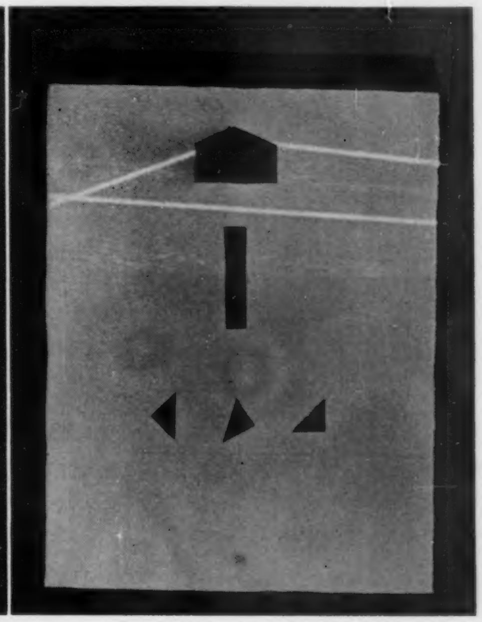
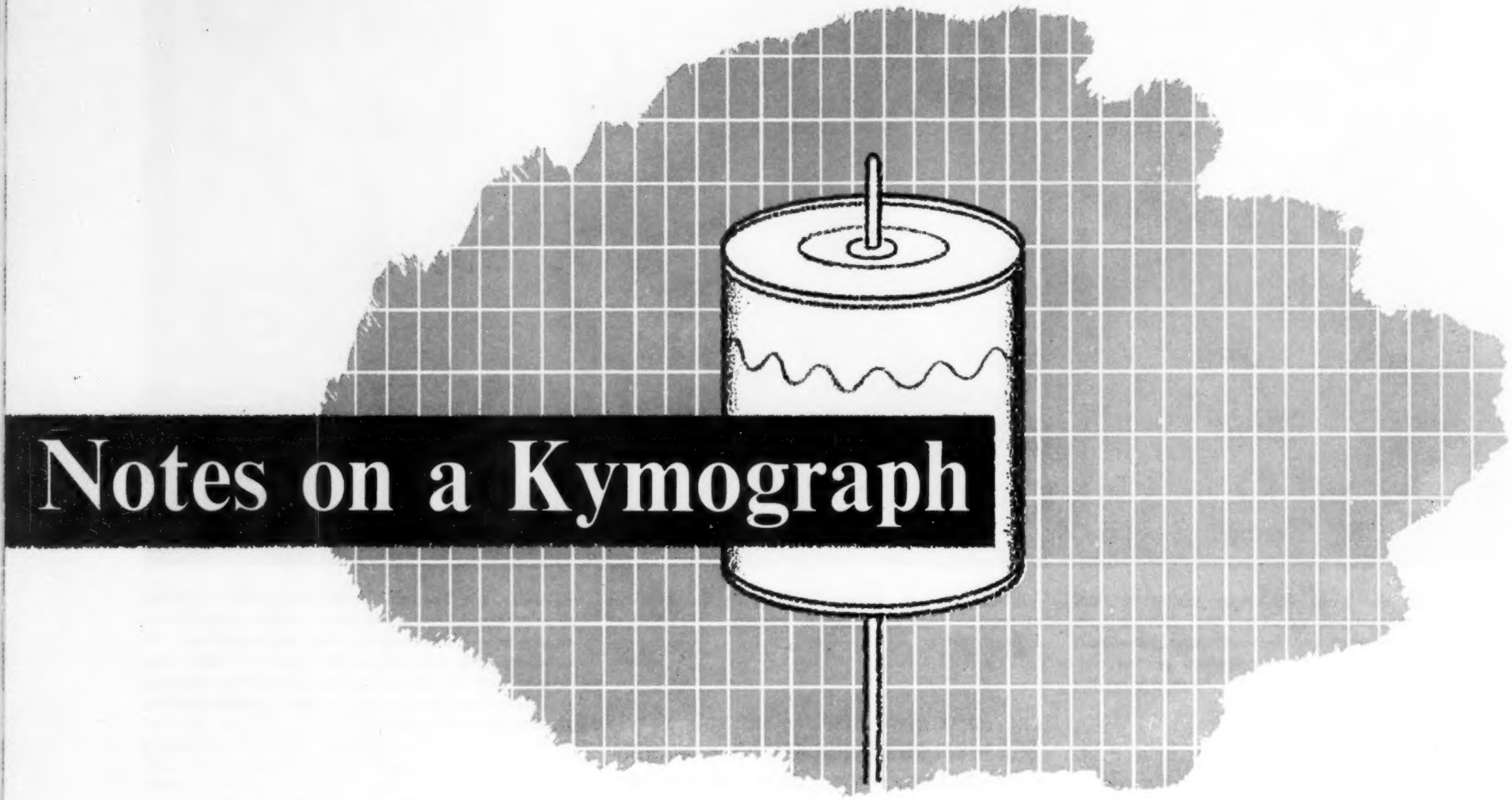


FIGURE 17. The same 45° prism rotated until it is in the position for minimum deviaiton.





Notes on a Kymograph

By HAROLD J. LEVY

Biology Teacher, Sheepshead Bay High School, Brooklyn, New York

FEW teachers will question the value of the kymograph as a tool in the biology laboratory, but a problem arises when the cost of the instrument is compared with the total amount of money a biology department has to spend for its supplies. A new kymograph and teaching kit costs $173.*

Since, in the past, I constructed a number of items that duplicated the work of professionally made models, I wondered what could be done about the kymograph problem. The recording drum would be easy enough to fabricate. The stumbling block for this project was the driving mechanism, but it was not insurmountable. Several of my son's broken toys solved the problem.

Many of today's toys are mechanical and are powered by tiny 1½-volt motors, which use ordinary flashlight cells for their power supply. One such toy was an electrically powered airplane. When I salvaged the motor(s), the wheels and rubber tires remained intact. All I had to do, I thought, was to mount the motor(s) in such a way that the wheels would rub against a movable drum, causing it to rotate.

After searching around the house, I found a large friction top can which formerly held five pounds of paradichlorobenzene nuggets. This I used as the kymograph drum. Since an ordinary ring stand was to be used as the axle around which the drum would rotate, I purchased a fourteen-inch threaded nipple (pipe) to serve as the main bearing. This was inserted through holes drilled through the center of the top and bottom of the can. Nuts secured the "drum" to the "bearing" and this entire assembly was placed over the ring stand "axle." (See Figure 1.)

I was now ready to test my idea. The motor was held up so that the rubber tires pressed against the drum. The motor strained and the drum whipped around briefly, but soon stopped. Even the motor ground to a halt. While the motor had high speed, it possessed very little power. A second motor improved the rotation, but not enough. If the kymograph were to succeed, some kind of inexpensive "transmission" would have to be inserted between the motor and the drum to cut down the speed of rotation and to increase the delivery of power.

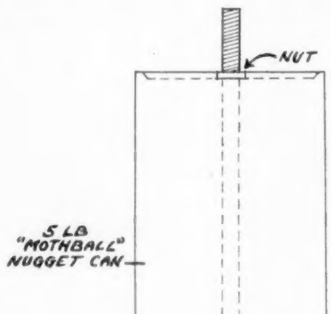


FIGURE 1. Detail of kymograph drum.

* 1958 price list of Harvard Apparatus Company, Dover, Mass.

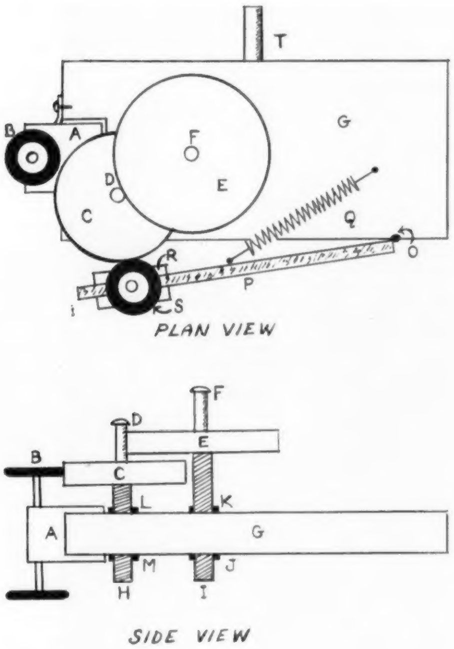


FIGURE 2. Detail of kymograph drive unit (plan view and side view).

A, R—1½- to 3-volt motors.
B, S—Rubber tire and wheel.
C, E—Jar covers (gear wheels).
D, F—¼" bolts (axles).
G—Wooden mount.
H, I—Threaded nipples (bearings for bolts D and F).
J, K, L, M—Nuts.
O—Hinge.
P—Wooden lever.
Q—Spring.
T—Metal dowel (for mounting power unit to ring stand).

My transmission was built one "gear" at a time using screw jar caps. The axles were made of bolts. Threaded nipples served as bearings. A ¼-inch bolt was inserted in a hole drilled through the center of a cap. Nuts secured the bolt so that the head of the bolt was about ¾-inches above the top of the cap. This part of the bolt was covered with friction tape to grasp the drum since these "gears" had no teeth. The entire "bearing" was mounted on a piece of wood. The motors drove the jar cap which turned on its axle, and the axle drove the drum. The power was greatly increased, but the drum still rotated a little too rapidly. It was necessary to add another reduction gear. This was made exactly as the first gear and mounted on the same piece of wood. Now the motors drove a jar cap which rotated on its axle, and the axle turned another cap which rotated on its axle, driving the drum. There was now plenty of power, and the kymograph drum turned very slowly. (See Figures 2 and 3.)

Accessories

A *femur clamp* for the nerve-muscle preparation was fashioned from an old coupling. (See Figure 4b.) One set screw holds the femur; while the other set screw holds in place the coupling to the ring stand.

Electrodes were made by taping two wires to a thin block of wood. (See Figure 4a.)

A *muscle writing lever* was made by inserting a short bolt through a thin steel lever. The bolt is the fulcrum. It is

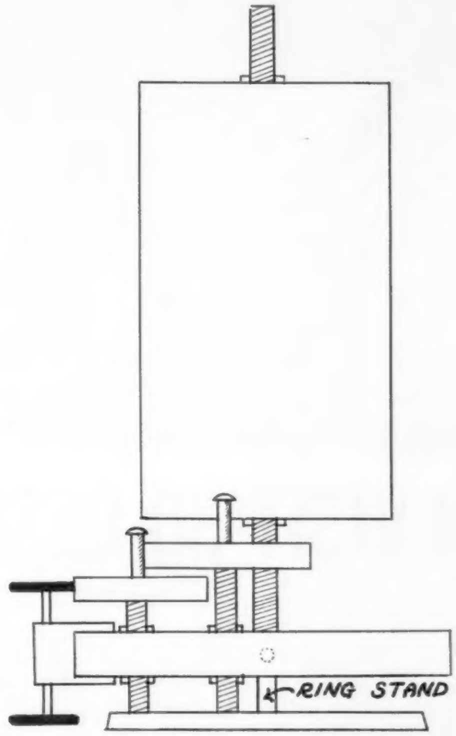


FIGURE 3. Entire kymograph assembly. For the sake of clarity, motor on hinged lever is not included.

supported by a very small block of wood which is attached to the ring stand by a dowel. (See Figure 4c.)

The *writing stylus* was made from ordinary shirt collar stays easily obtainable. (See Figure 4c.)

A *signal magnet* was made from an electric door bell. The gong was removed, and a stylus was attached to the hammer. The contact points can be left alone or they can be tied down, depending upon the use. The entire "bell" was mounted on a small piece of wood which has a dowel mounting. (See Figure 4d.)

A *pneumograph* was made by attaching a rubber tube to either an ordinary

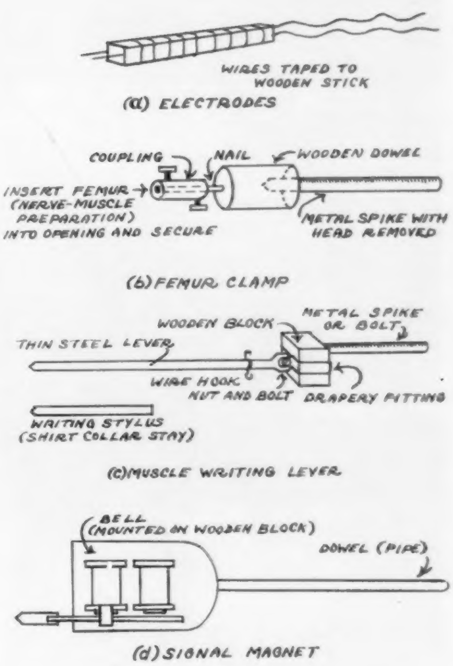


FIGURE 4. Kymograph accessories.

hot water bag or to the top of a plastic bottle if this is used.

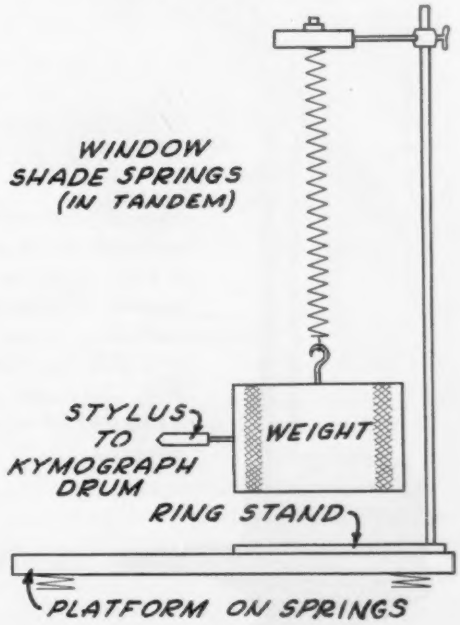
Operation

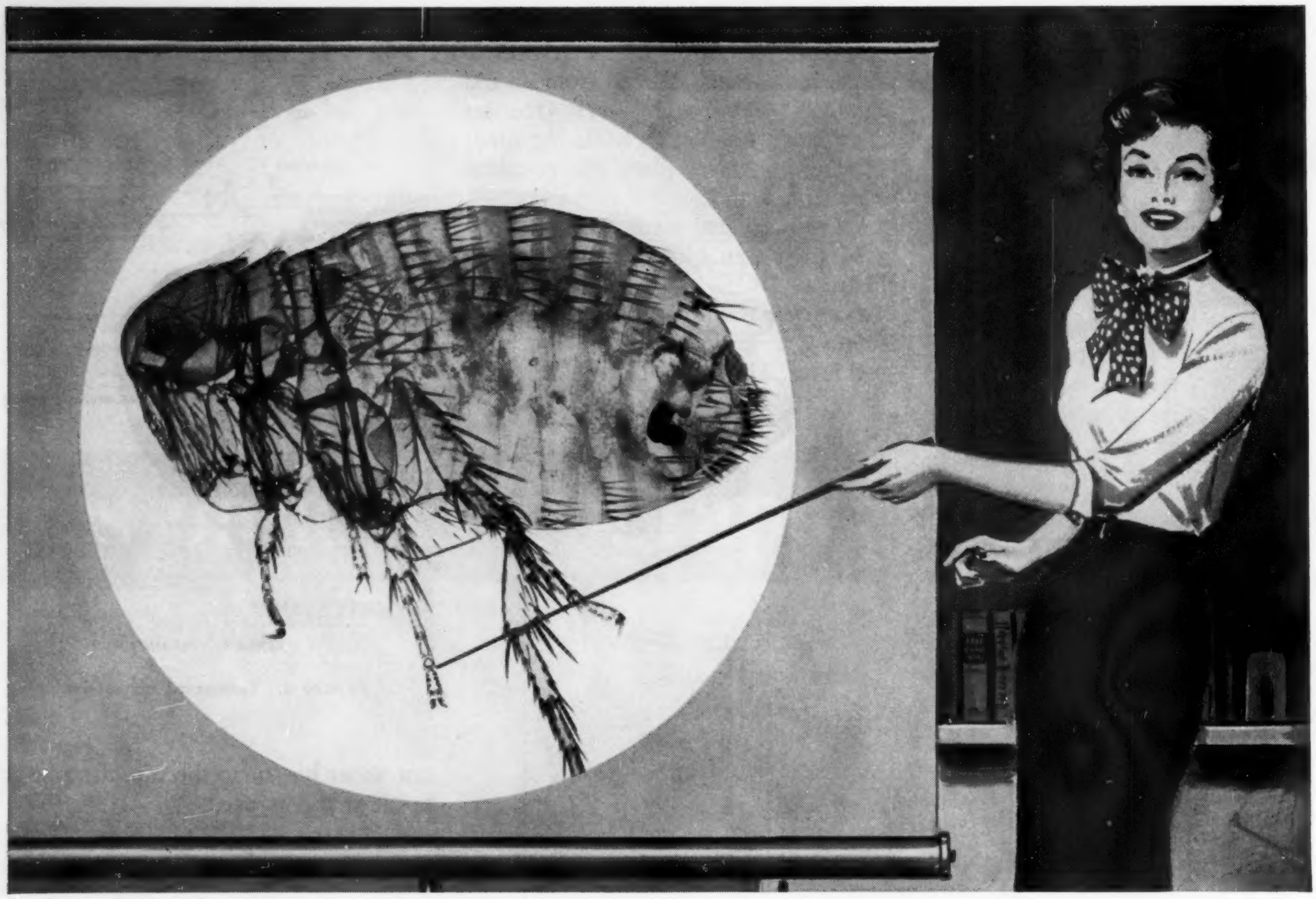
(Refer to Figure 6)

It is quite evident that the kymograph really works. Since I did not have an induction coil or its equivalent available, it was not possible to stimulate muscle tissue electrically.

A nerve-muscle preparation responds in a specific way when it is stimulated.

FIGURE 5. Application of kymograph to demonstrate vibrations (for an earth science class).





My problem was to see if my homemade parts worked as well as the kymograph itself. My own muscles, therefore, were harnessed to the muscle writing lever. Figure 6d shows that the lever was successful.

Figure 6(a and b) show breathing curves. They were recorded using a pneumograph and sphygmograph tambour. The tambour was the only professional equipment used, in addition to the recording paper. The pneumograph in Figure 6a was an ordinary rubber hot water bag. The pneumograph in Figure 6b was an empty polyethylene bottle of "Elmer's glue." In both cases, the pneumograph was held between the chest and a belt. A rubber tube connected the pneumograph to the tambour.

Figure 6c was recorded using a thistle tube and the tambour.

Uses in General Science

1. A stylus mounted on a tuning fork and held against the drum will illustrate vividly the relationship of vibration and sound.

2. The signal magnet with the contact points operating can be used to make a graph of the vibration rate per second. If the contact points are tied down and another graph is made, the two graphs can be compared, and the function of the contact points will become clear.

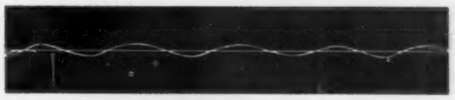
3. The effect of gears on direction of rotation and speed of rotation can be demonstrated by using the kymograph transmission.

Earth Science

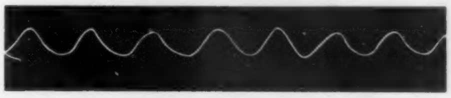
The kymograph can be used to record vibrations if a seismograph is available.

If a very heavy weight is supported by a spring, and the spring is supported by a fixed object, the weight will remain in a fixed position due to its inertia, even if there is a vertical movement of the earth. This can be recorded by securing the "seismograph" and the kymograph to a platform which is mounted on springs. The platform should be vibrated. (See Figure 5.)

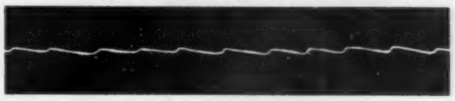
If you want to record horizontal movement of the earth, the kymograph must be mounted horizontally by supporting the "upper" end of its ring stand axle.



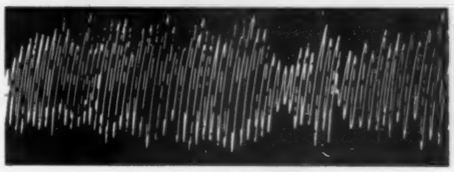
(a) "Hot water bag" pneumograph.



(b) Respiration curve—using Elmer's Glue bottle as a pneumograph.



(c) Carotid pulse.



(d) Muscle contractions.

FIGURE 6.

THE KETTERING CHEMATHON

By VICTOR M. SHOWALTER

Chemistry Instructor, Fairmont High School, Kettering, Ohio

CHEMISTRY and other sciences are essentially activities which are quite individualistic. Except for the more spectacular experiments and demonstrations, the excitement of chemistry is contained within the individual. The *Chemathon* was conceived to extend the excitement of chemistry beyond the individual to a large group of people.

High school teachers have learned that student interest in school activities varies with the amount of public recognition of that activity. Science fairs, essay contests, and competitive examinations have contributed to a growing realization by the public that science is important in the high school. These forms of recognition, however, are unlike the personal interest developed by the nonparticipant while watching a football game, a performance by the marching band, or the presentation of a class play. In these activities, the spectator has become an integral part of the event and the resultant public support often has been overwhelming. In fact, people like, even demand, a feeling of importance, or *ego* satisfaction, and respond with all types of encouragement, in order to "build winners."

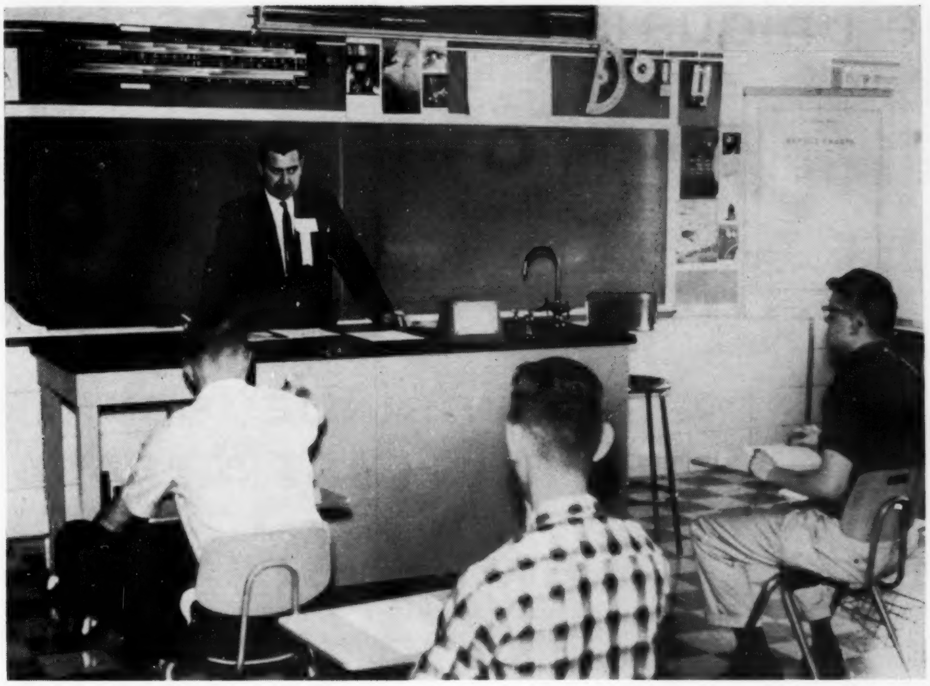
The basic idea for the Chemathon was "hatched" during a student-teacher bull session following a typical Pep Assembly which interrupted a chemistry laboratory session. The feeling was expressed that it took just as much ability and physical coordination to perform an acid-base titration as it did to dribble a basketball. Further, the public should be made aware of this fact.

Essentially, the Chemathon idea was to do some desk and laboratory events in an atmosphere of competition to stimulate spectator interest and develop student ability. Since the instigators of the Chemathon idea thought it would be a challenge to participate in such a contest, it was decided that five laboratory and five desk events should be prepared and that the local Science Club should sponsor and publicize the public presentation. The only stipulation made was that each event must be short enough to hold spectator interest. Each laboratory problem should accomplish a given task in the shortest time while maintaining certain standards of accuracy and neatness. Each desk event should consist of doing the most problems of a given type correctly within a specified time limit. A scoring system should be devised to determine an ultimate winner, somewhat in the manner of the Olympic decathlon.

When sponsorship of the Chemathon was suggested to the Science Club, great enthusiasm resulted. Within a few days a committee had drawn up official Chemathon rules and the afternoon of the annual Science Fair (project judging was confined to the morning) had been set as the date for the "World's First Chemathon." Awards, in the form of trophies, for first, second, and third place winners were purchased from the Science Club treasury.

The first public announcement of the Chemathon was made in the school newspaper, followed by notice in city newspapers, school bulletin boards, and chemistry classes. Included in the news releases were official rules and a list of expected knowledge which would serve as a basis for the events. Preliminary registration for the Chemathon was so great that qualifying trials had to be conducted in order to narrow the field to the final group of twelve. The qualifying trials, held two weeks before the

NOTE: The author acknowledges the following who offered suggestions for this article: S. Winston Cram, Emporia State Teachers' College, Kansas; John Maurer, University of Wyoming, Laramie; and Arthur Scott, Las Cruces High School, New Mexico.



A desk event is about to begin as a faculty judge instructs the contestants on the official procedure.

finals, consisted of one desk and one laboratory event. These were conducted as prescribed by the official rules.

Several students eliminated in the preliminaries volunteered to act as laboratory assistants in preparing for the final events. As it turned out their assistance was invaluable. Two were assigned the roles of official judges for the desk and laboratory events. The judging team was completed by the addition of two faculty members.

Finally, the day of the world's first Chemathon arrived. Preparations were complete, the trophies were on hand, assignment sheets for each event had been duplicated, equipment and chemicals had been double-checked, laboratory assistants had been briefed on their duties, the judges had memorized the official rules, and twelve silvered miniature test tube pins were ready to present to each of the contestants. These were presented to the contestants as they were initiated into the "Order of the Silver Test Tube," midway through the Chemathon.

At two o'clock, all Science Fair projects had been judged, the contestants had drawn lots for laboratory work stations, about forty spectators were on hand, and the Chemathon was under way. The first event, a laboratory problem involving preparation of 250-ml hydrogen, was completed in fifteen minutes. The contestants then moved to the adjoining physics room for a desk event. Ten minutes later they returned to the chemistry room for the second laboratory event. The results of each event and a running total were scored on a large portable chalkboard. This scoreboard, which captured considerable attention from contestants and spectators, soon became the focal point for the whole Chemathon.

By mutual consent of the contestants the last two events were omitted. After two hours and eight events of intense concentration and sometimes frantic activity, the final scores were totaled and the trophies were presented to the winners of the first Chemathon. The response by students and public during the afternoon was so great that a second Chemathon is in the making, this time on an interschool basis.

Chemathon Action

To start a laboratory event, the contestants first drew lots for a work station in the laboratory. All work stations were equipped identically. A limited supply of equipment and chemicals was available at the laboratory station. An assignment sheet had been placed face down on the table. At a given signal from the chief judge the assignment sheets were turned over and work was started.

The equipment and chemicals were selected to put a premium upon resourcefulness as well as chemical knowledge. For example, one laboratory problem was to "prepare a visible sample of metallic copper." The chemicals available were wire form copper (II) oxide, crystalline copper (II) sulfate, aluminum foil, powdered charcoal, and distilled water. Available equipment included a burner, a beaker,

Chemathon contestants draw for laboratory stations prior to the first laboratory event. The assistant stands by with silver test tube pins to identify and honor the finalists.


THE BOOK OF
Popular
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One contestant's answer to a slow filtration during a laboratory event. This event will not be a part of future Chemathons because it lacks the speed to make the competition interesting to spectators.

a file, forceps, test tube and holder, flask, matches, and paper towels. It seemed as if each contestant tried a different approach to the problem. One tried a carbon reduction but couldn't find any metallic copper when the mixture was placed on the paper towel after heating (caution against fire must always be observed). Another tried to use the aluminum foil to replace copper ions from a solution of the sulfate. Result—nothing. He later found that scratching the foil with the file exposed enough metallic aluminum and replacement occurred. The ultimate winner of this event heated a piece of the copper (II) oxide in the reducing flame of the burner and then cooled it in the nonburning section of the gas-air mixture.

As has been noted, the object of each laboratory event was to finish the assigned task first. One point was awarded for each competitor who was passed. Since there were twelve finalists, this meant that the first-place winner of each event was awarded eleven points; second-place, ten points; third-place, nine points; . . . eleventh-place, one point; twelfth place, no points. One of the judges' chief jobs was to note the order of finish and the winning time. To add to the contestant's sense of accomplishment, each winning time was recorded and regarded as the "world's record" for that event. When all contestants had finished a laboratory event, the judges inspected each work station and in a few cases arbitrarily realigned the official order of finish on the basis of careless work.

As soon as the official order of finish was scored on the scoreboard, the contestants moved to an adjoining room to begin a desk event. The judge in charge of the desk events placed an assignment sheet face down on each desk. At a given signal, the contestants began. At a second signal, usually ten minutes later, all work stopped and the papers were collected for scoring. The assigned problems of a given event were all similar and consisted of such things as balancing equations or writing the names of elements. Sufficient problems were included in each event so that no one would complete all. During the desk events, no books or other references were permitted, but a slide rule was allowed.

The desk judge evaluated the desk event while the contestants were working on the next laboratory event. The number of correct answers or responses determined the order of finish and, as with the laboratory event, one point was awarded for each contestant defeated.

While the desk event was going on, the laboratory assistants and judges hurriedly prepared the laboratory stations for the next event. If the materials had not been prepared and boxed ahead of time, undue confusion and delay could have resulted.

The spectators were most interested in the laboratory events, however, a few of them followed the contestants into the desk events and watched. At first, this seemed to distract one or two of the contestants but they soon learned to become accustomed to the presence of spectators.

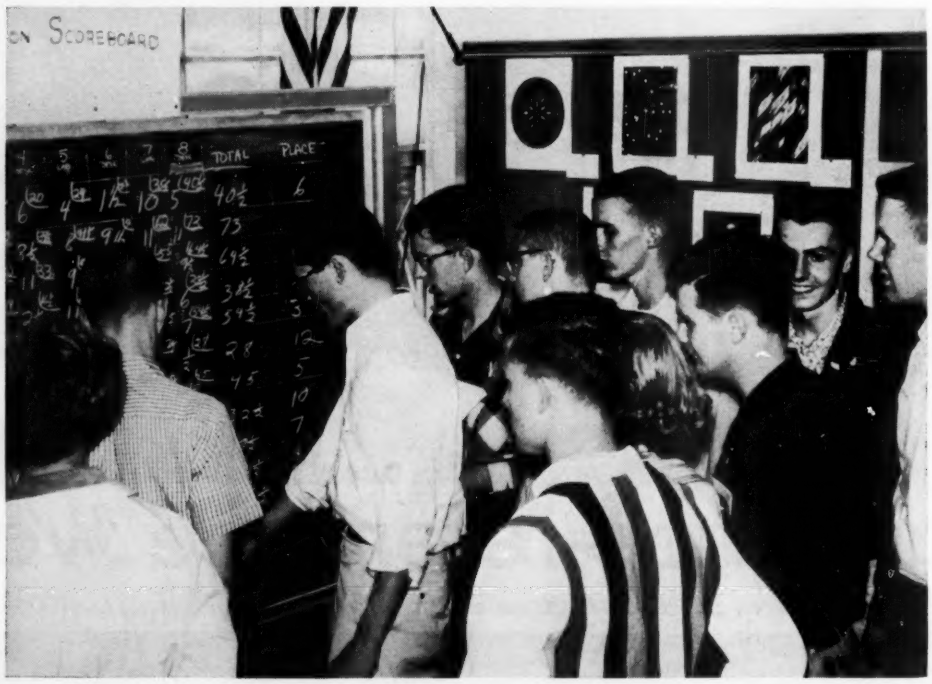
Some idea of the closeness of the contest may be realized by the winning scores—first place, 80.7 per cent of the possible points; second place, 79.0 per cent; and the twelfth or last place, 32.4 per cent of the possible points.

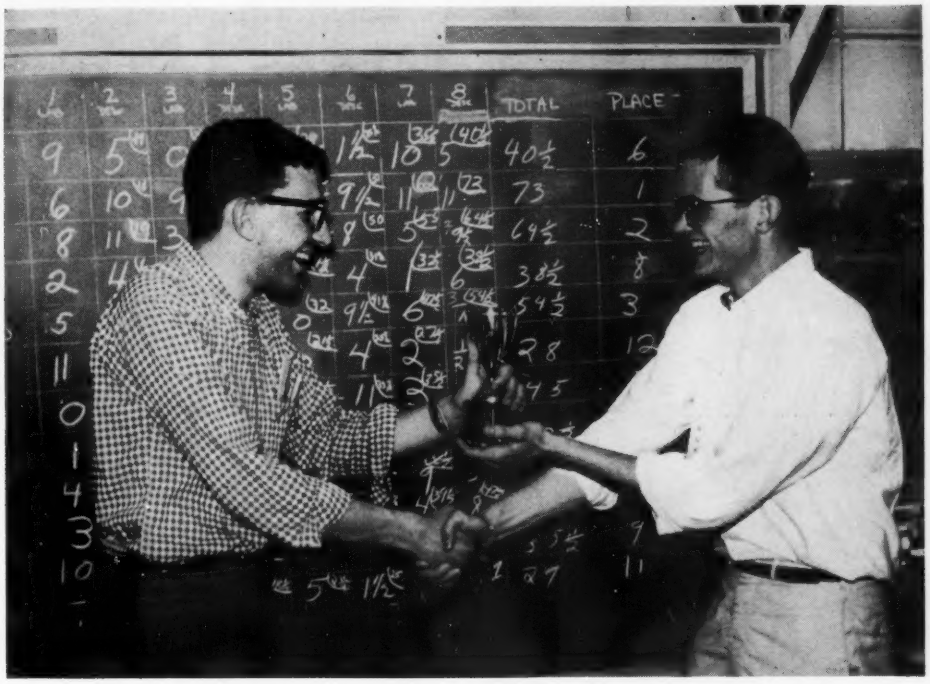
Guide for Developing Events

In planning and conducting a Chemathon, several guides must be kept in mind.

1. All events must be short. Ten minutes is a maximum length.
2. Laboratory events should be simple. Sufficient resourcefulness can be demanded by using imagination in the selection of the materials made available.
3. Specific space should be allotted to spectators and they should be confined to this area.
4. Each participant must be thoroughly familiar with the rules, especially the official finish signal for laboratory events.

Contestants and spectators gather around the official Chemathon scoreboard while the head judge totals the points to determine the winner.





The winner of the world's first Chemathon is presented the first-place trophy by the head judge.

5. It is desirable to conduct preliminary events two weeks before the finals. This may be needed to select the finalists but, in any case, it should be done to familiarize the contestants with the general procedures and to accustom them to working under pressure.
6. Each laboratory and desk event should be tried ahead of time. For desk events, the students will require nearly twice as much time as the teacher. Laboratory events will be completed in about the same length of time required by the teacher.
7. Some means must be available for keeping the spectators posted on the progress of the contest. A large scoreboard is ideal.
8. Desk events should be arranged so that spectators may see as much of the proceedings as possible.
9. A tie-breaking event should be available if two or more contestants finish with identical totals.

Benefits Derived from the Chemathon

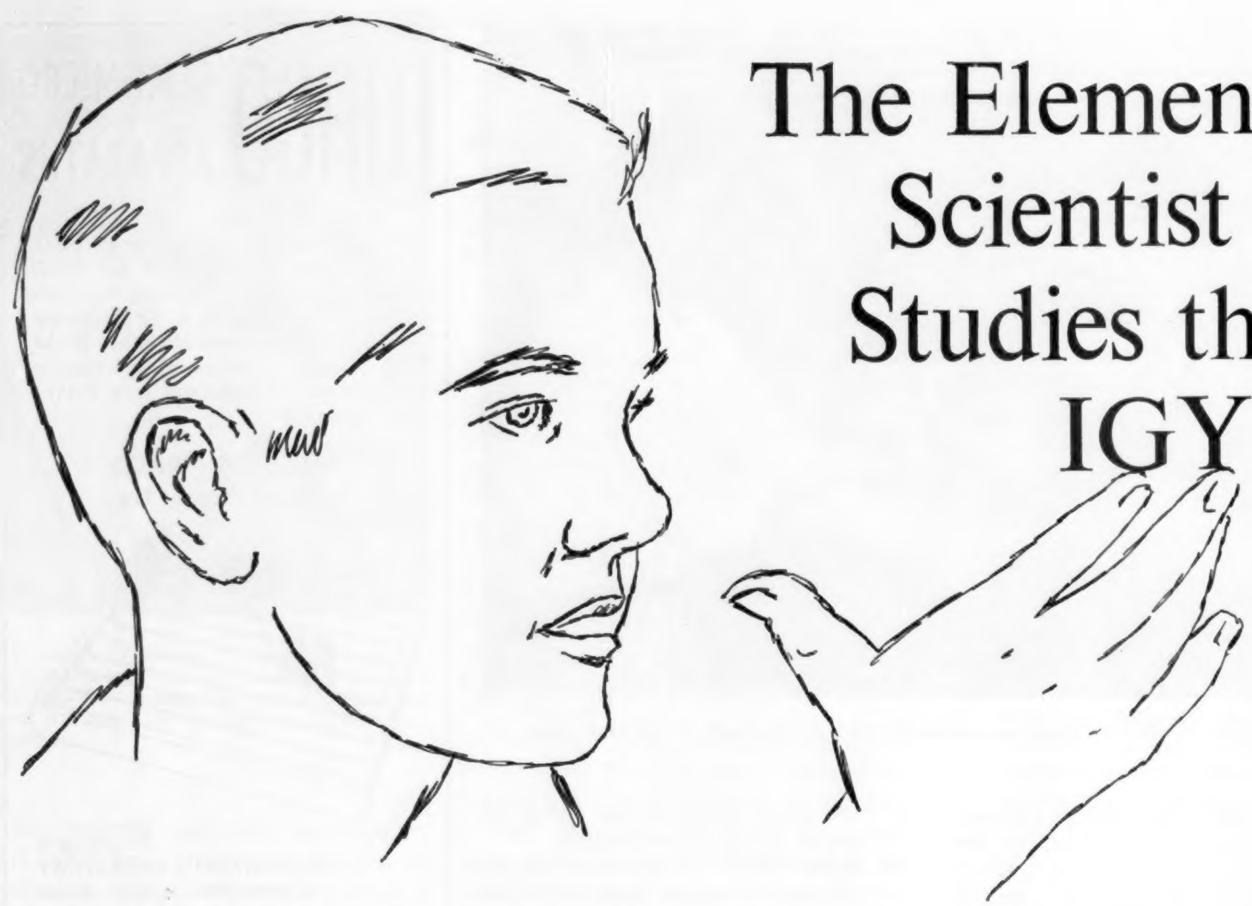
Though we have conducted only one intraschool Chemathon at Kettering, we can appreciate and foresee many specific reasons for continuing the event. Among these are:

1. The capable chemistry student is challenged to develop his abilities and resourcefulness beyond the standards of the usual class.
2. All students enrolled in chemistry are made aware of the values of sound laboratory techniques.
3. Public interest is developed in the chemistry program specifically and the total science program in general.
4. The awards and public attention give recognition and a touch of glamour to the able chemistry students and to chemistry as a subject.
5. When held in conjunction with a Science Fair, the latter gains more of the diversity implied by the term. The Chemathon adds a dynamic factor to a sometimes static exhibition.

At the conclusion of the first Chemathon the participating students, all juniors, immediately proposed a *Physathon,* or *Biothon,* for the next year. With a little imagination, these events could be conducted and possibly do for their respective sciences what the Chemathon has done for chemistry.

At this writing, there are no Chemathon cheerleaders at Kettering. The stadium is not even equipped with gas outlets at the 50-yard line, but who knows what the future holds for Chemathon leagues? State Chemathon Championships? Chemathon by mail? The possibilities are unlimited.

NOTE: The author submitted lists of Chemathon Regulations and Assignment Sheets used in this experiment. Readers interested in obtaining more information are requested to write the author directly.



The Elementary Scientist Studies the IGY

By MATTHEW J. BRENNAN

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NEVER before in our history have the minds and interests of the children of the nation been directed toward science and the activities of scientists as they were during the period of the International Geophysical Year and in the continuation of IGY earth and space programs to the present moment. As a result of these interests, children in elementary schools are discussing—and gaining an understanding of—concepts formerly thought to be far too advanced for them. Only last week I visited a fourth-grade class in which a youngster was explaining to his classmates the principles of jet and rocket propulsion and giving a demonstration to illustrate his point. Two points impressed me: here was a nine-year-old boy explaining a complicated Newtonian law of motion; and here was a whole class which would not spend their lives believing one of the most common misconceptions in science—that jets are pushed through the air by their exhaust gases. Impressive also was the fact that he was using a few five-cent balloons for his demonstrations, not a dangerous homemade rocket which some teachers feel is necessary to make this a "real" experience.

Although this is not a typical case, there are many areas of IGY activity which can be used for elementary science experiences. It will be the purpose of this article to discuss some of these and suggest possible activities which can be carried out.

I. Why Was the IGY Planned?

Scientists were aware of many deficiencies in their knowledge of the earth and its atmosphere, its magnetic fields and variations in the force of gravity from place to place, the oceans around us, the effects of solar disturbances on the ionosphere, and the status of the earth's glaciers. Even the exact locations of some of the earth's features were not known. Hence the "G" for geophysical, for the emphasis was to be the physics of the earth.

Perhaps more important in the planning was the feeling among scientists that they had reached the limits of their knowledge to be gained from isolated observations. The need now was a world-wide network of stations which would take simultaneous observations of all geophysical phenomena. Only in this way could they know the relationships among solar and magnetic storms, auroras, or cosmic rays. Only in this way could they provide synoptic maps of world-wide activity in all areas similar to those used by the meteorologist in the preparation of the weather map.

There were also some parts of the earth, such as the Arctic Ocean and the Antarctic Continent, which had not been explored.

Such a world-wide program required the cooperation of every nation in the world—hence the "I" for International.

Suggested Questions for Elementary Science

1. How far has man probed into the earth? In wells for water? Oil?
2. How far has man probed into space? With planes, balloons, rockets?
3. How far has man probed into the oceans?
4. What is the shape of the earth?

II. Why Was the IGY Planned for 1957-1958?

The period of IGY was planned to coincide with the period during the eleven-year sunspot cycle when the number of sunspots would be at their maximum. During this period, scientists expected a maximum of solar disturbances which in turn would provide maximum disturbances in the behavior of some of the phenomena to be studied, such as radio communications and the earth's magnetic field. There seemed to be a relation between sunspots and solar storms, explosions and flares, which give off charged particles, X rays, and ultraviolet light. To alert all IGY stations to these periods of solar activity and expected increases in atmospheric disturbances, a worldwide network of 27 solar laboratories watched the sun and the world warning center at Fort Belvoir, Virginia broadcast alerts to prepare scientists for increased observations during a "Special World Interval" or SWI if the anticipated disturbances materialized.

The IGY period proved to be well chosen. It started on July 1, 1957 with one of the largest recorded solar storms and continued as a period of considerable activity.

COLUMBIA SCHOOL, PEORIA, ILL.

Sixth graders study weather phenomena, an important IGY activity.

Suggested Activities

1. Locate on a map or globe the solar stations at Mount Wilson Observatory; the High Altitude Observatory at Climax, Colorado; the Harvard and Air Force Station at Sacramento Peak, New Mexico; and Fort Belvoir, Virginia.
2. If you haven't seen the Bell Telephone Company film "Our Mr. Sun," show it to your classes. If they have seen it, review the parts on sunspots and solar eruptions and flares. In this way you can give your children an experience in the classroom which they could not have in any other way. (This to me is the time test of the value of any film in the educational program.)

III. Where Were the IGY Stations Located?

If this sounds like a geography lesson, that is intended. For in the study

A classroom display of easily constructed materials makes science experiences real and accessible to the elementary student.

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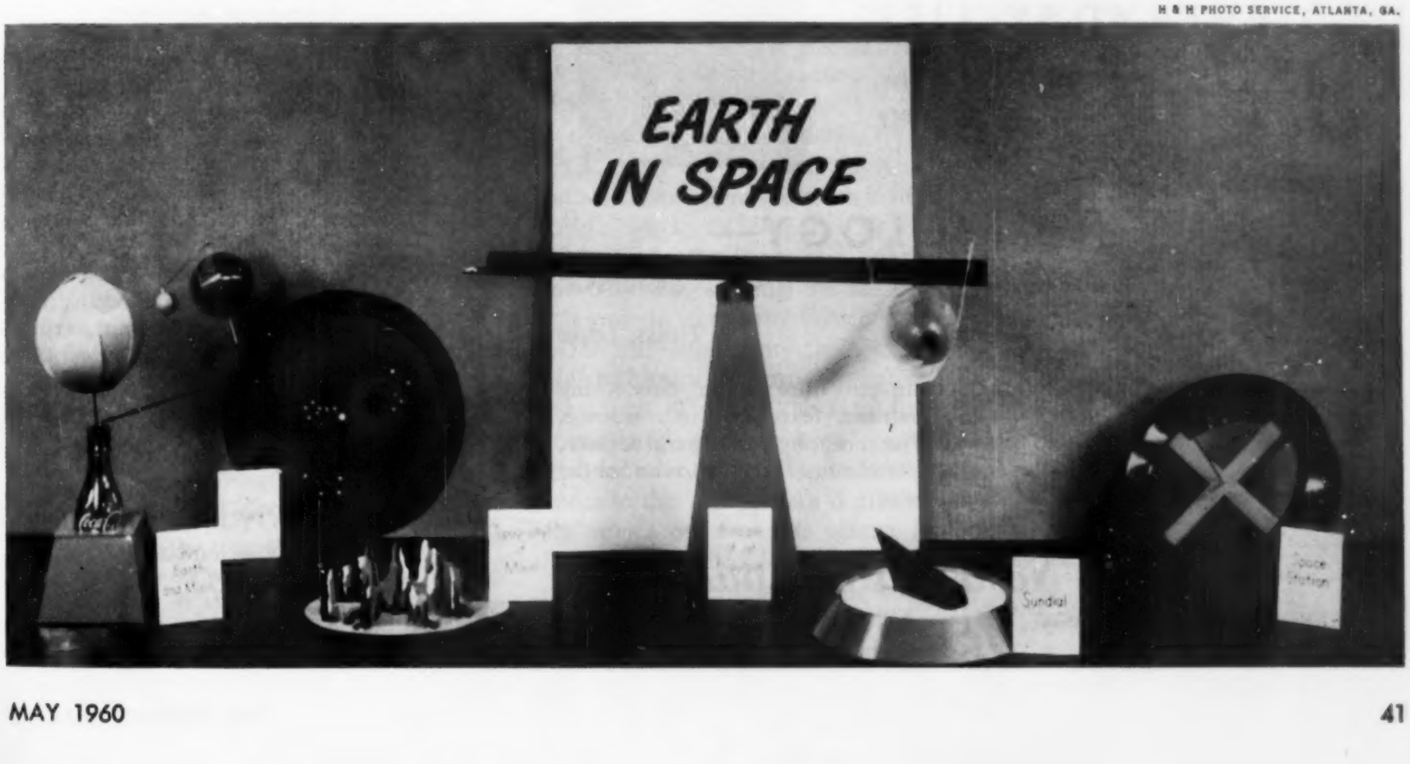


of the earth, you cannot study science without studying geography, nor vice versa. And even though you cannot, many teachers do it every day. But in IGY planning, geography was extremely important for two reasons.

A. One goal of IGY was to make more accurate studies of the effects of latitude on measurements of various phenomena. To accomplish this it was necessary to establish chains of stations extending from pole to pole along various meridians or lines of longitude. Three such meridional chains of stations were established: one along 75° W; one along 10° E; and the third along 140° E. A look at the map will indicate the logic in these choices. The first passes through the eastern United States, down the West Coast of South America, and along the Palmer Peninsula in Antarctica. The second passes through the Scandinavian Peninsula, Central Europe, and the western coast of Africa to Antarctica. The third passes through Manchuria, Japan, some of the major Pacific islands, and central Australia to Antarctica. By taking advantage of previously existing stations along these lines, it was possible to complete the meridional chains of stations by the addition of relatively few new stations.

B. Location of Antarctic and Arctic stations was based on the geographic positions of the geographical, magnetic, and geomagnetic poles of the earth as well as the meridional chains of stations for which they formed the terminals.

Suggested Activities

1. Trace the three meridional chains of stations used in IGY planning and observation. Can the children locate another meridian which would be as good? That would have as many cities along it where laboratories were probably already located?
2. How much did the American stations in Antarctica and on the floating islands in the Arctic contribute to the completion of the three chains of stations?
3. Locate the geographic, magnetic, and geomagnetic poles and equators.

IV. Areas of IGY Investigation for the Elementary Scientist.

A. Meteorology.

Since the topic of weather is covered in all elementary texts, no

NATIONAL ACADEMY OF SCIENCES, IGY PHOTO

Crevasses can be large or small, potentially dangerous or scientifically productive. Fortunately, the crevasse is too narrow to allow the Sno-Cat and three-ton cargo sled to drop below the surface.

time will be spent on this area here except to point out some additions to the ordinary weather observations which were made in the Arctic and Antarctic during IGY. These were measurements of solar radiation received upon and radiation from ice and snow surfaces. The results of these measurements will be important in answering questions of whether we are receiving more heat from the sun than we are losing by radiation in these areas. Accurate calculation of the heat and water budget of the earth will require this information.

Suggested Activities

1. Measure the temperatures of black, orange, and white objects placed in the sun. Why did the scientists on the Antarctic traverses paint their vehicles orange? Black? Were there other reasons besides temperature, such as visibility from the air?
2. Set up a classroom weather station.
3. Why is Antarctica classified as a desert?

B. Glaciology.

The other big factor in the heat and water budget of the earth is the world's glaciers, 90 per cent of which cover the Antarctic continent. Are they melting, increasing, or remaining constant? Fossils and coal in the sedimentary rocks indicate a former warm climate in Antarctica. The thickness of the Antarctic glacier has been measured as over two miles in many places in the interior. As it gradually moves out from its center, it thins out until it is less than 1000 feet thick at the edges of the continent and in its ice shelves. The Antarctic glacier can be likened to

NATIONAL ACADEMY OF SCIENCES, IGY PHOTO

This seventy-foot crevasse yielded valuable information on the study of ice deformation. (Camp Michigan near Roosevelt Island on the Ross Ice Shelf in Antarctica.)

a thick pancake batter poured on a griddle, thick in the middle and thinning out as it flows out to the edges. The portion which passes out past the edges of the continent and floats on the ocean is an ice shelf. Two of the United States stations in Antarctica were located on ice shelves which rise and fall with the tides: Ellsworth Station on the Filchner Ice Shelf and Little America Station on the Ross Ice Shelf. It has been estimated that if this ice melted, the level of the oceans would rise over 150 feet. Your class can spend weeks finding out how many of our coastal cities would still be above the water level if this happened.

Children are also interested in crevasses. They have seen pictures of large crevasses in the earth in which people, equipment, or houses have disappeared. Crevasses are simply cracks which form in a glacier as it bends and stretches and passes over mountains and valleys beneath. There is no limit in their size as they grow from tiny cracks to huge caverns hundreds of feet deep.

Suggested Activities

1. Try the pancake demonstration of glacial movement and thickness.
2. Locate the cities which would be under water if the glaciers melted.

C. Magnetism.

Remember that the earth is a big magnet with north and south poles just like your classroom bar magnet. Relate these poles to the location of your town or city. Do the classic experiments with iron filings to show the lines of force around and between the poles. You will be able to see why the radiations from space can more easily penetrate this magnetic field at the poles where the lines of force are vertical to the earth's surface. You can more easily understand why the cosmic rays, auroras, and radio disturbances are more prevalent in the Arctic and Antarctic, and why these areas were so important in IGY planning.

D. Airglow.

One of the questions most frequently asked by children in the elementary school is: "How can animals see in the dark?" IGY research into the little-known area of airglow may supply the answer to this question. I know you are asking, "What in heaven's name is airglow?" Simply stated, it is the light in the sky when it is dark out, or light caused by chemical reactions in the ionosphere. Have you ever noticed how much darker it is when clouds shut off this light? Scientists using photo-multipliers can detect red, green, and yellow-orange colors in the airglow. Most important for our question, however, is a more intense (yet invisible) infrared glow coming from OH ions (charged combinations of oxygen and hydrogen). If our eyes were sensitive to this infrared light, we would never experience an outside darkness darker than dusk. It is possible that our raccoons, cats, skunks, mice, and owls are able to see the infrared airglow and thus see as well in our darkness as we can at twilight.

E. Related Activities of IGY.

Although the IGY program of research was directed in the area of geophysics, it was not possible for scientists and United States Navy support personnel to ignore the animals around them, especially in the Antarctic, where we find the fascinating penguins, seals, whales, and sea birds in such large numbers. Most people think of the Antarctic as a barren land devoid of life. Yet penguin rookeries of over 250,000 population have been found, and thousands of whales are killed every year. The waters off Antarctica are so full of fish, shrimp, and smaller plant and animal life that these animals find plenty of food. A 50-ton whale can get all the food it needs simply by swimming through the water and straining out the food organisms in the water which pass through its mouth. Off the ice shelf at Ellsworth Station we found sponges and coral in freezing water 3000 feet below the surface. And one generally thinks of these as animals of shallow tropical waters.

F. Integration of IGY Science Activities in the Elementary Curriculum.

We have already discussed the relation of the IGY sciences to geography. The success of the program was equally dependent on some events of considerable historic significance. During IGY nations forgot their differences in an important cooperative venture. Russian meteorologists as well as those from other countries worked together in the American weather control at Little America. Americans spent time during IGY studies at the Russian base of Mirny. A recent treaty makes Antarctica a free territory set aside for scientific work by all nations without national claims to the territory.

There is no limit in the activities to which a study of IGY can lead, except perhaps from a disinterested teacher. Children will read more, draw more pictures, make more measurements, and dream up more stories about the sun, moon, and the satellites than even you can imagine. Don't stop them!

Large crevasses formed by the movement of ice and snow are a source of information on stratigraphy and petrofabrics of ice and snow. (Little America Station.)

OFFICIAL U. S. NAVY PHOTO

AO Reports on Teaching with the Microscope

A tax-free anti-pollution program . . . or natures' answer to man's profligacy!

Pollution is the sad legacy man leaves behind in his headlong rush to inherit the earth. A provident nature works hard to restore balance and order.

Mr. Verne Gowe sends this fine experiment which illustrates nicely how nature uses biological action to help purify streams and lakes.

You'll need microscopes and a colony counter for this experiment. American Optical makes a very excellent, inexpensive colony counter we would like to sell you. It is universally used by school, clinical and industrial laboratories. However, in a spirit of complete unselfishness, we pass along Mr. Gowe's instructions for a do-it-yourself counter that should prove adequate. This same generous spirit moves us to tell you about the excellent microscopes you can buy from American Optical (you really wouldn't want to try to make your own). If you need microscopes for your school and refuse to compromise quality and performance for price, then write to us at dept. E95. Ask for brochure SBTI. There's no obligation, of course.

EXPERIMENT

The Effect of Biological Action on Pollution

By: Verne Gowe
Warren Township High School
Gurnee, Ill.

MATERIALS AND PREPARATION:

1. AO Spencer No. 66 Student Microscope with 10x eyepiece and 10x and 43x objectives. 2. Bacterial colony counter. 3. A 4x hand lens. 4. Clean slides and cover slips. 5. Screw top collection jars. 6. Nutrient agar. 7. Petri dishes. 8. Pipettes—1 ml.

PROCEDURE:

A. Collect water samples

1. Choose a stream that has pollution entering from storm tiles or other sources. In most areas this is not too difficult to find.

Fig. 1

2. With *sterile* screw-top jar, collect a water sample at the source of pollution. Take three additional samples at different stations down stream from the source of pollution. Make all sample collections at the surface of the water.
3. Make careful observations along stream for other sources of pollution and factors that might have an effect on results.

B. Microscopic Examination

1. Observe a few drops from each sample under 100x (10x objective and 10x eyepiece) of the microscope for an over-all view of what might be present (Fig. 1). Check for algae, rotifers, protozoans (Fig. 2).
2. Under high power, 430x (43x objective and 10x eyepiece) identify as many of the microscopic forms as you can.

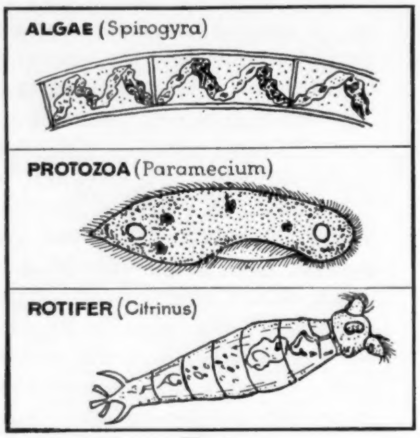


Fig. 2

C. Make pour plates

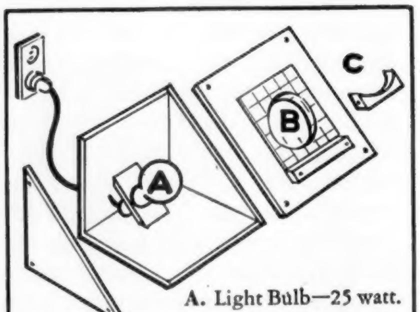
1. Melt a bottle of sterile nutrient agar by heating it in a pan of water. After the agar is completely melted, cool to 42° - 45° C.
2. Place 1 ml of water from source of pollution in a sterile petri dish using a sterile 1 ml pipette. Pour enough agar in to just cover the entire bottom. Mix by swirling gently. Let the agar-bacteria mixture stand until it hardens. Invert the dish and store in a dark place to incubate for two days at room temperature.
3. Follow this same procedure for each of the other samples. Label each for identification.
4. After incubation, pour plates of the samples should be observed for bacterial colony growth. Colony counts should be made with a bacterial colony counter (Fig. 3). Note the difference in counts according to the distance from the source of pollution. Make a graph or charts of the quantities and types of colonies found at different stations.
5. Compare the kinds and numbers of organisms seen under the microscope with the bacterial colonies. Make charts to show comparison.

Fig. 3

D. How to make a Colony Counter

A simple bacterial colony counter can be made as follows:

1. Build a wooden light box with a hole the size of a petri dish in the slant side (Fig. 4). Place a glass plate over the opening and rule vertical and horizontal guide lines about ½" apart on this plate. With a 4x hand lens you will be able to count the colonies within each guide-line square.



A. Light Bulb—25 watt.
B. Opening, size of petri dish, covered by lined glass.
C. Wood block to hold petri dish.

Fig. 4

OBJECTIVES:

This experiment not only awakens an interest in conservation of our streams through better sanitation controls but also illustrates:

1. A basic bacteriological method used in Public Health Laboratories.
2. The effect of microscopic organisms on pollution.
3. Nature's method of stream purification.
4. Interdependence among living organisms.

American Optical Company

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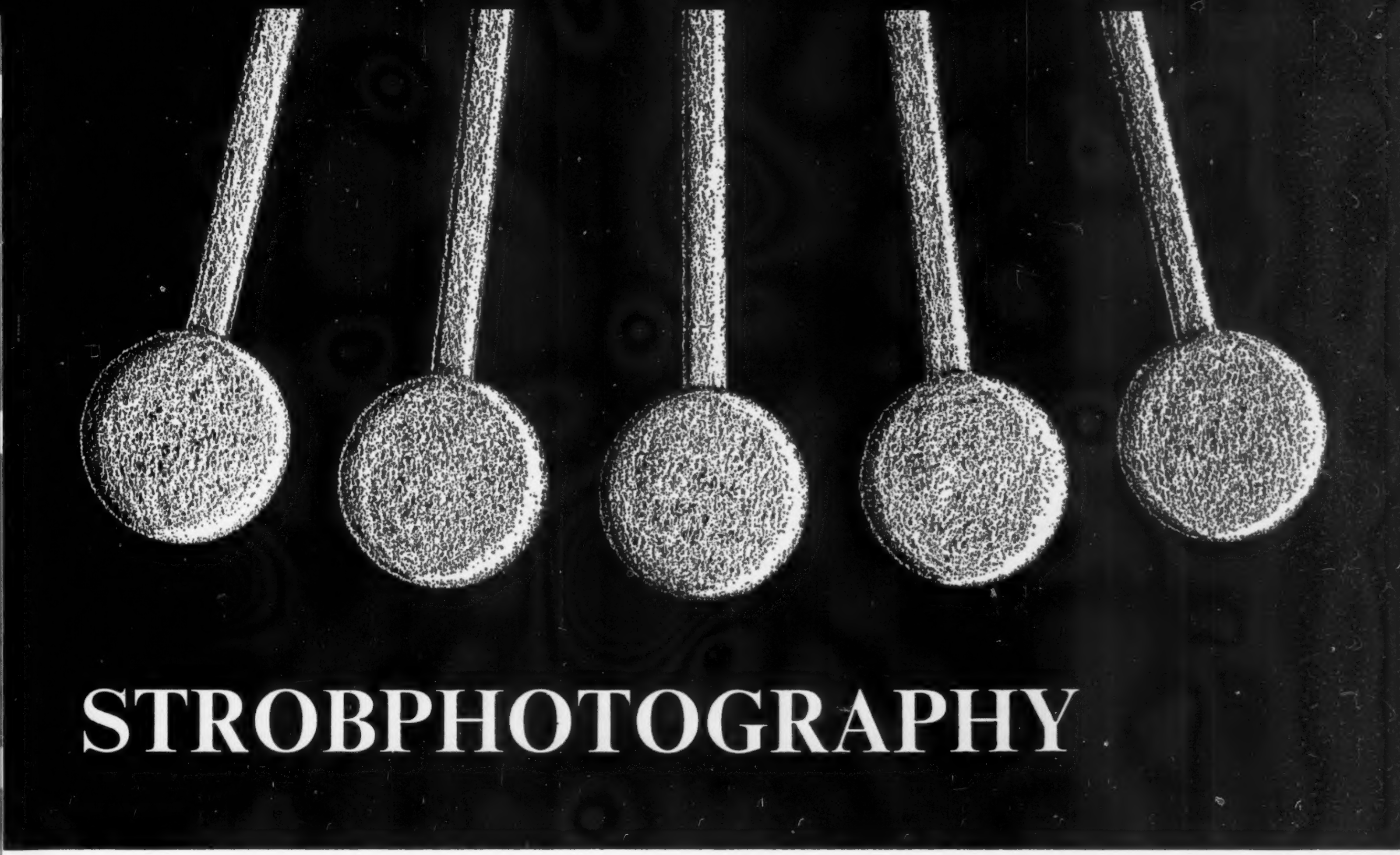


STROBPHOTOGRAPHY

By DARRELL TOMER

Science Teacher, Hanford High School, Hanford, California

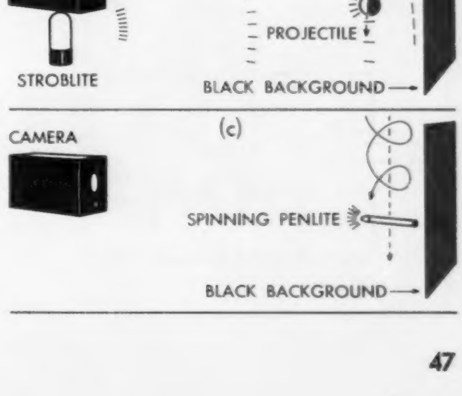
INTEREST in kinematics and dynamics will run high in your classes if your students can use stroboscopic techniques to investigate the laws of force and motion. Demonstrations using the stroboscope are effective for stimulating interest, but the combined use of camera and strob results in interest plus permanent records students can analyze quantitatively at home.

You can bring strobphotography into your high school physics classroom by any one of three different methods. They are: (1) intermittent exposure, (2) intermittent illumination, and (3) intermittent, or flashing objects. (See Figure 1.) The heart of all three methods is the camera. Any camera with a bulb or time shutter release will do, but whenever possible the use of a Land camera and a Keystone overhead projector is recommended. The Land camera using type 46L film (ASA 1000) permits the results to be almost immediately available and obviates the necessity of reassembling the apparatus for a second try later, if the pictures are not satisfactory. The Keystone overhead projector, designed for 3¼" x 4" size, enables the entire class to view the results simultaneously and to the original scale if desired. It can also be used to project the results directly onto a page of the student's notebook, permitting him to trace in the projectile positions for analysis as homework. An extremely convenient feature of the Keystone overhead projector is that it makes an ideal source of illumination for the photography.

Whatever camera is used, the procedure for applying it is basically very simple:

1. Load the camera with fast film (ASA 80 or faster).
2. Set it for widest aperture (lowest f-stop).
3. Place it from 3.5 to 8 feet from a black background (4' x 4' pegboard painted flat black, a large black cloth, or an open doorway into a darkened room).
4. Turn on your illumination and strobing systems.

FIGURE 1.



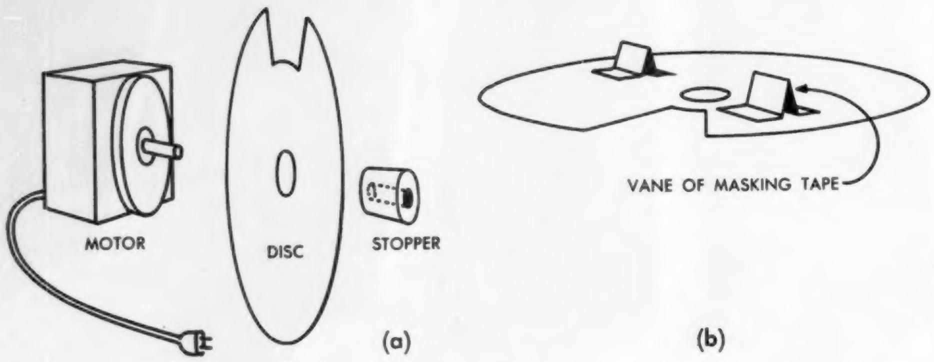


FIGURE 2.

5. Open the camera shutter.
6. Send the moving object across the background.
7. Close the shutter.
8. Develop the film (overdevelopment helps contrast).

The resulting film will show a series of images of the moving object. Since these images were formed successively at equal intervals of time, the distances between any two images is proportional to the average velocity at which the object passed between the corresponding positions. Your students will quickly learn to translate this curving array of images into data and conclusions regarding the acceleration and forces experienced by the ball.

METHOD I. INTERMITTENT EXPOSURE (strobing the camera).

You can make a simple strobing device for your camera by mounting a cardboard disc on the shaft of most any small motor. Phono motors of the shaded pole type are about right. Mount the disc on the motor shaft by cutting a hole in the center of the disc to receive a small one-hole stopper. Push the stopper tightly into the disc, then over the motor shaft. (See Figure 2a.)

Depending on the type of motion being studied, a wide range of exposure rates (views per second) will be found useful. For falling objects within the classroom, exposure rates of from ten to forty per second will work. If the motor turns too fast, the simplest thing to try is increasing the air resistance of the disc with masking tape vanes. (See Figure 2b.) Some motors can be controlled by rheostat or variac. A surefire method is gear or pulley reduction. If the motor does not turn fast enough, more than one slot can be cut in the disc. Be very careful to cut the slots accurately at one-half, one-third, or one-fourth of the full circle. If only one slot is cut, keep the disc balanced by pasting the two halves of the cutout piece right next to the slot. (See Figure 3.)

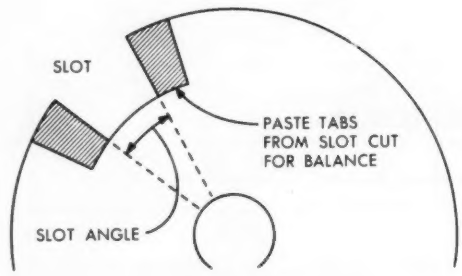


FIGURE 3.

Paint the disc flat black and mount it and its motor as close to the camera lens as possible. To make a disc with an adjustable slot, put two identical slotted discs on the same shaft so one is movable. If the angular width of the slot is not more than 10 per cent of the angular distance between slots, the blurring of the image will not be objectionable. A ring stand and burette clamp will support the camera strob, or the strob and camera can be mounted together on a board.

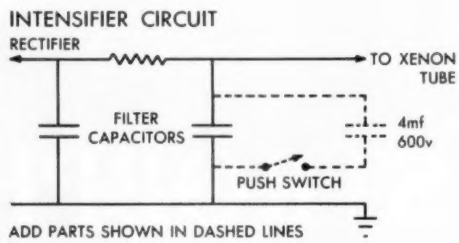


FIGURE 4.

Computing Exposure Time and Rates

A challenging problem for your students is figuring out how to compute the number of exposures per second and the length of each exposure. If the speed of the motor is known (see Time and Distance Scales), the exposure rate per second is given by the formula:

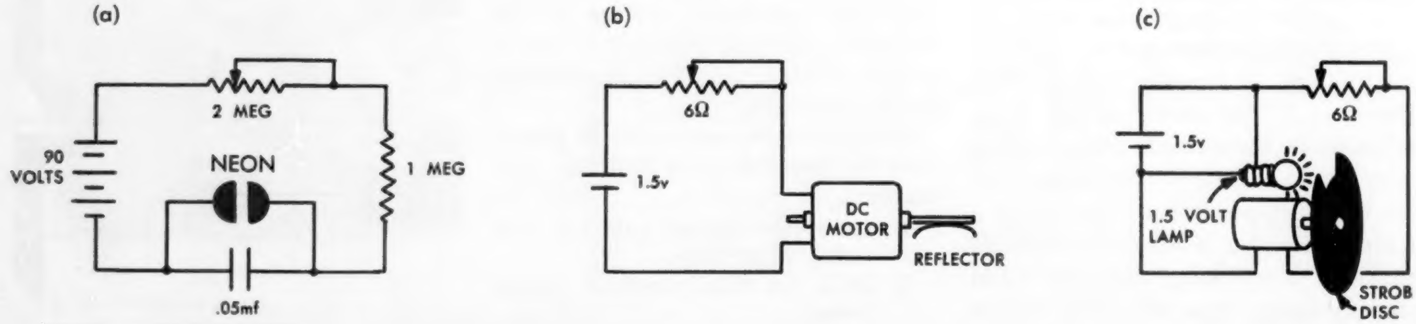
$$\frac{\text{exposures}}{\text{second}} = \frac{\text{rpm}}{60} \times \text{slots}$$

The width of the slot and the speed of the motor control the exposure duration.

$$\text{seconds exposure} = \frac{\text{slot angle}}{6 \times \text{rpm}}$$

An exposure time of 1/250 second will usually be sufficient for objects freshly coated with flat white spray paint and

FIGURE 5.



illuminated by the Keystone overhead projector or by a 200-watt lamp provided with an aluminum foil reflector and placed beside the camera.

You are now ready to investigate accelerated motion by Method I. There are other devices by which Method I can be applied, but these do not seem practical for the usual high school laboratory.

METHOD II. INTERMITTENT ILLUMINATION (strobing the light).

Some seemingly simple ways of applying this method are not very practical. These include using movie cameras and fluorescent lamps as illuminators, and strob discs in front of a lamp. Electronic strobs using neon lamps do not give enough light for photography. One thing that will work is a xenon tube similar to those used in electronic photoflash guns. At least one company* offers such a tube for sale, together with instructions for constructing the simple power supply and oscillator to operate it. If the intensity proves to be inadequate for photography, an intensifier circuit can be added (see Figure 4) which will increase the brilliance at some sacrifice in tube life. This same company will also supply the completed instrument with calibrated dial and intensifier switch. Strobphotos taken with xenon stroblite are very spectacular and precise.

METHOD III. INTERMITTENT OBJECTS (flashing or oscillating objects).

The use of an intermittent object is the simplest system of strobphotography; it is also the most certain to produce sufficient contrast. You can learn to throw or drop a penlite with a spinning motion so each time it points toward the camera, a bright spot will be recorded on the film. You can make a simple self-strobing pendulum by suspending a neon lamp (operating on 120 volts, 60 cycles) by its AC cord. The type of neon lamp doesn't matter, but if the electrodes are too tiny, you may need a magnifier to examine the results.

A more versatile self-strobing object consists of a 90-volt radio dry battery, potentiometer, capacitor, and neon lamp. (This will make a good project for a student interested in electronics.) When connected as in the diagram (see

* Wabash Instruments & Specialties, Inc., P. O. Box 194, Wabash, Indiana.

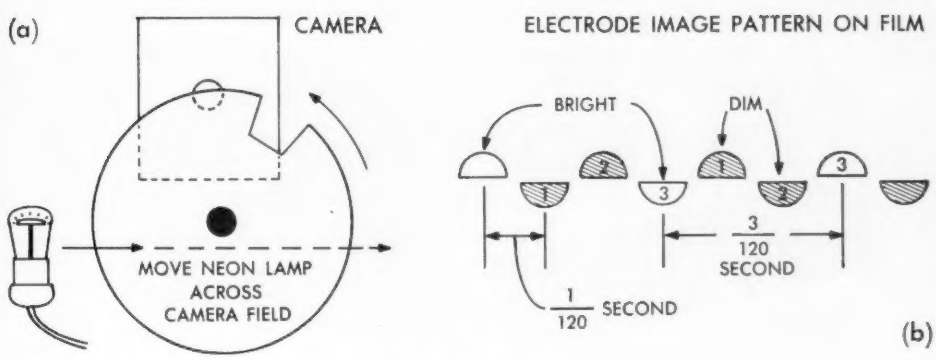


FIGURE 6.

Figure 5a), the lamp will flash periodically. Exact values of circuit components depend on the particular neon lamp. Start with the values shown, and if the frequency range is not satisfactory, increasing the values of resistance or capacitance will increase the period, and vice versa. If the lamp appears to glow steadily, it is either flashing so fast you cannot detect the period, or the resistance of the potentiometer is too small, letting enough current pass to keep the lamp glowing when the capacitor has discharged. The parts can be taped to the battery, forming a single bundle that can be thrown as a projectile, swung as a pendulum, or given a ride on a cart down an inclined plane.

Another less expensive device consists of a small concave mirror glued to the shaft of a 3-volt toy motor. (See Figure 5b.) The mirror is a half-inch disc of aluminum foil which has been pressed against a large marble. The motor and 6-ohm rheostat can be fastened to a single flashlite cell wired as shown in the diagram. With this object, the best results will come from placing the light source right beside the camera. You can do away with the lamp and improve contrast by substituting a small strob disc for the concave mirror and placing a penlite lamp behind the disc. (See Figure 5c.)

Time and Distance Scales

Distance Scales: While it is beneficial for students to learn to work with arbitrary units, they should also know how to establish conventional units. Students should be allowed to solve the distance scale problem by their own ingenuity. Some methods you might expect them to use to reach their solutions are photographing a meter stick held in the plane of action; flashing a penlite at two points one meter apart; or drawing a grid on the blackboard used as a background. A convenient method is a piece of pegboard painted flat black, so that its holes, one inch apart, will show in the photographs. Also, certain accessories to be mentioned later attach easily to the pegboard.

Time Scales: Establishing the time scale may take a little more thought. If the strob motor is synchronous as a known frequency, or if calibrated electronic strob is available, no problem exists. Another approach is to use a photoelectric cell and oscillograph. Other ways based on the 60-cycle line current include synchronous motors, vibrators, and neon lamps.

The neon lamp method works well with the disc strob. Set up the camera and strob disc as if to make a strob photo of a moving object, but have the strob disc cover only two-thirds of the lens opening. (See Figure 6a.) Open the camera shutter and move the lighted neon lamp across the field of view.

Every flash of each electrode will be recorded because the lens opening is always partly uncovered, but some flashes will be recorded more brightly since they occur at the instant when the strob slot exposes the full lens. On the picture count the number of electrode images from one bright image to the next and you have the strob period in units of 1/120 seconds. (See Figure 6b.)

The synchronous vibrator is applicable to an uncalibrated xenon stroblite. A DC doorbell with its breaker points shorted out will run synchro-

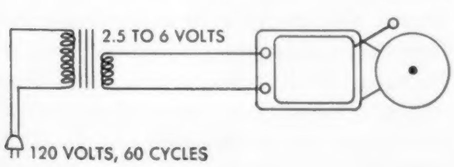


FIGURE 7.

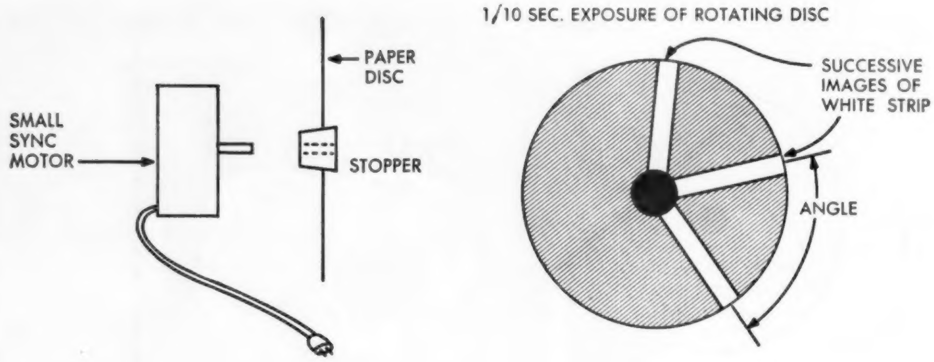


FIGURE 8.

nously on a six-volt transformer. When the vibrator is examined under the light of the xenon strob, the submultiples of 60 cycles can be detected by the visible behavior of the vibrator. (See Figure 7.)

The synchronous motor method is applicable to both Methods I and II and can utilize synchronous motors too small to turn a heavy cardboard stroboscope disc. Some small synchronous motors available without reduction gears turn at 7.5 cps. Provide one of these motors with a 4-inch diameter white paper disc and spray it black except for a radial strip ¼-inch wide extending radially from center to edge. (See Figure 8.) Hang this motor and disc on the pegboard facing the camera and photograph it at 1/10 second using either the strob disc or the stroblite. If the strob frequency is 15 or more per second the developed film will show at least two images of the radial white line. From the synchronous motor speed and the angle between the images of the white line your students can compute the strob frequency:

$$\frac{\text{exposures}}{\text{second}} = \frac{\text{rpm}}{60} \times \frac{360}{\text{angle}} = \frac{2700}{\text{angle}}$$

Moving Objects for Methods I and II

Among your laboratory supplies you may find a variety of objects suitable for projectiles. The best surfaces are either diffuse white or polished reflecting. Diffusing objects can be lighted either from the front, side, top, or bottom, but objects that reflect like mirrors should be illuminated by a lamp placed next to the camera. For some experiments the effects of air resistance are to be avoided and high density objects are preferred. More challenging acceleration experiments can be set up by throwing low density objects, like styrofoam balls, horizontally across the field of view. Large diffuse objects tend to form overlapping images when speeds are low or strob frequencies are high. This can be avoided by the use of spherical concave or convex reflectors like steel ball bearings or polished chrome cabinet pulls. These form small images of the illuminating lamp and appear on the film as points of light.

Other Accessories and Uses

In addition to the calibrating devices you may want to make other accessories for your strobphotography kit. Examples are an inclined plane and cart, a pendulum hanger, or a second law of motion demonstrator. These can be designed to fasten to the pegboard. Strobphotos of collisions between elastic spheres in space are very effective for investigating the laws of conservation of momentum and energy. For this, suspend two spheres as pendulums from long threads that hang parallel when the two spheres just touch at rest. Pull the spheres aside at different angles and amounts, one at a time or together, then turn loose and photograph the resulting action. The camera should be either directly below or above the action.

Test the concept of center of mass with a strobphotograph of an elongated object thrown through space with a tumbling motion. Do not forget those exciting stroblite examinations of rotating, waving, and vibrating objects. You can even teach a little mathematics with your stroblite techniques; a flashlite lamp on the rim of a turning wheel can generate ellipses, cycloids, and sine curves. Which one of your students can throw a ball the fastest? Which one can shake a stick with the highest frequency? Which can exert the greatest force on a ten-pound free weight? Let your students decide how to put such questions to the strob equipment.

Classroom IDEAS

General Science

Microphotographs with the Microprojector

By WALTER P. LARTZ, U. S. Grant School, Sheboygan, Wisconsin

The following method has given me excellent results in making microphotographs of current subjects encountered by students in almost every phase of general science. This method is particularly useful for those who do not possess a suitable camera or do not have the equipment necessary to process the film.

FIGURE 1.

Equipment needed is a microprojector, photo contact paper (F4 or F5 for sharp contrast), and developing and fixing chemicals easily obtainable at a photo supply store (Figure 1).

Set up the apparatus and procedure as follows:

1. Select the slides to be projected and mount them in the projector.

2. From left to right, lay out the developing and fixing trays. [For a 4 x 5-inch sheet of contact paper three 1000-ml beakers will work nicely in place of trays; one beaker for developer (Dektol), one for plain water for rinsing, and the third for the final fixing solution (Hypo-sodium thiosulfate).]

3. Darken the room. (Contact paper will take some latitude of light so the room is not completely dark.)

4. Align the paper under the microprojector as shown in Figure 2 and turn on the lamp. (If the arc attachment can be taken off, a 100-watt slide projector works nicely.)

5. Expose from 6 to 17 seconds, depending upon the amount of light being projected. (Make small test strips before spoiling large sheets.) The exposure will vary with subjects.

6. Develop 1½ minutes in the developer, rinse in the water about 1 minute, and then leave in the hypo for about 10 minutes.

7. Wash the hypo out of the prints by leaving in running water for about 15 minutes and then dry by putting between blotters.

Once shown the procedure the students can easily produce prints from slides of their own making.

Small cut-out arrows from black drawing paper, laid on top of the print while being exposed, will emphasize any particular part of the print you desire. These arrows will show up as white on the completed print due to the reversal of black and white. These white arrows may then be used for easier identification of points you wish to emphasize. Printing on the white arrows may be done by typing on the finished print or by the use of India ink or a grease pencil.

FIGURE 2.

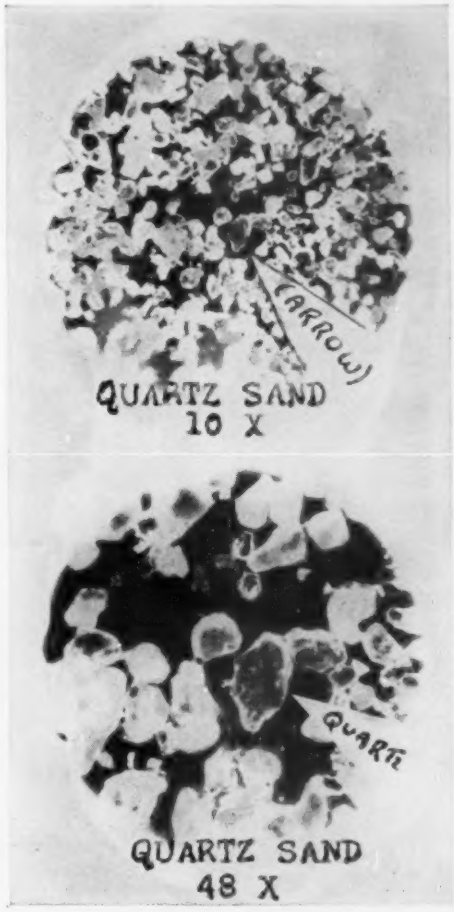


FIGURE 3.

Actual photos of sand grains on contact paper are shown in Figure 3. Note arrows for identification. In Figure 4 is a print made from a prepared slide of pine needles.

FIGURE 4.

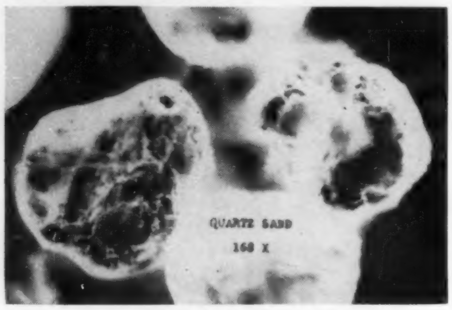


FIGURE 5.

These prints can be used for cutouts themselves or three-dimensional models, drawings, or bulletin board work.

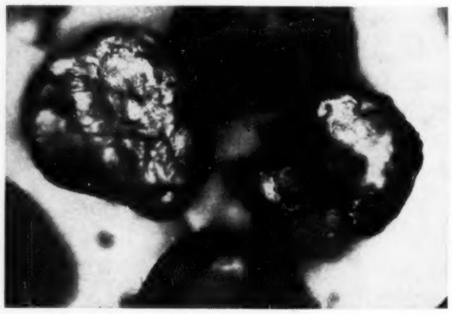
Due to the "negative" quality of the prints, white shows up as black and vice versa, a new approach is given to the subjects themselves. I have found that these prints are especially useful for the study of sand grains for the emphasis is given to the grains which stand out against the dark background.

To change to a normal, or positive print, use the "negative" print you have just made as a negative and expose fresh contact paper by placing the two sheets together (emulsion side to emulsion side) between two glass plates for good contact and hold toward the light with "negative" print on the side toward the light. (Once again, use test strips first.)

The print in Figure 5 is a "negative" made directly by exposure under the microprojector. Figure 6 shows a "positive" print made by exposing to the print in Figure 5.

Enlargements can easily be made by this method also. Keep in mind that the greater the enlargement the longer must the exposure be under the projector. (Use F4 or F5 paper.) The only change is that *enlarging* instead of contact

FIGURE 6.



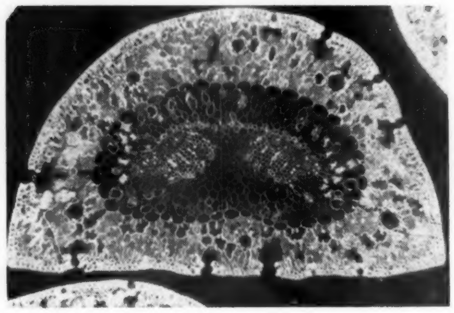


FIGURE 7.

paper must be used for the enlarging paper is much more sensitive to the reduced light coming from the microprojector. (The room must be *very* dark for this particular work.) I use enlarging paper for prints of subjects larger than 50X.

An enlargement is shown of the pine needle to 168X made with the microprojector (Figure 7).

The above suggestions will produce accurate and effective prints for classroom study and are only a few of the fascinating and instructive ideas which can be used to make a more effective teaching device.

NOTE: The two classroom ideas that follow were cash-award winning entries in the STAR 1960 awards program, conducted by NSTA and sponsored by the National Cancer Institute, U. S. Public Health Service.

General Science

How to Teach 36 Hours a Day

By RICHARD F. BLAKE, Stratford High School, Stratford, Connecticut

The real value of any teaching aid is measured by the student's willingness and ability to use it freely and the effectiveness of the lesson taught. Any teaching aid should also be convenient for the teacher to prepare, versatile in its uses, and fairly inexpensive. This paper is being written because an experiment using the tape recorder as a teaching aid was so successful in all of these aspects that it has become a permanent and growing part of the Science Program at Stratford High School.

The experiment started by preparing half-hour tape recordings on specific topics in chemistry to aid the student who had been absent or needed extra help on specific topics and as a means of review before midyear or final examinations. The program later included topics especially for students who wanted more advanced work than is usually presented to the entire class as a part of their course.

These tapes were used by individual students or by small groups of students after school. By using earphones, individual students used the tape recorder in the rear of a classroom, or in the school library during a study period. The tapes were also charged out like library books to students who had tape recorders at home.

The first topics chosen were those from chemistry that most often caused student difficulty and were well suited to talk-and-chalk explanations. These topics included the naming of elements and compounds, writing formulas and equations, and the various mathematical problems based on formulas, equations, and the gas laws. At the beginning of each tape the student was reminded that he would need certain materials such as pencil, paper, periodic table, and slide rule, and it was suggested that he turn off the tape recorder and get anything that was missing. The instructor then gave a brief explanation of the topic much as he would in a class-

room except that it was "talked out" in the quiet and comfort of his study. This has several advantages: (1) The teacher was not concerned with student behavior or the interruptions that often come in a classroom; (2) Notes and sample problems were laid out on the teacher's desk so that the organization and presentation of the topic went exactly as planned; and (3) As the project was discussed the teacher wrote down any notes, equations, or figures that a student might want to record so that the rate of the presentation would be reasonable for the listening student. Sample problems and equations were done as part of the discussion, a trial problem was dictated, and the student was told to "turn off the tape recorder and solve the problem." After he had solved the problem or attempted to solve it, he could turn the tape recorder on again and compare his method of solution with the correct one described on the tape. A similar procedure was used to give the student practice in writing equations and in answering thought questions.

For about two weeks after the first tapes were available they were not used. Then a few students came in for some help on writing formulas. They were given the tape on "formulas" and a tape recorder and were asked to try it. The response was immediate. These students came back each afternoon until they had used every tape available. Other students also came in to hear the recorder. Each evening several of the tapes were taken home, and many class periods saw the tape recorder in use with the earphones. Once before the midyear examination, a student took home six tapes and had a "jam session" with a group of his classmates. Although each tape was planned for 30 minutes, some students would use it as long as two hours. They would rewind the tape and go over explanations several times repeating the sample problems until they really understood the procedure. In these cases the machine had a great advantage over a live instructor. For a student who is a little slow or self-conscious, it is embarrassing to ask an instructor to repeat and repeat, but the student could make the machine repeat as often as he wished without taking anyone's time and without feeling any embarrassment. Another indication of the success of this experiment was the number of student requests for additional and more advanced topics. Some of these topics have been prepared.

The first set of tapes have now been used for three years. Each year the pattern has been about the same—a new group is slow to start using the tapes, but after a little encouragement a few students do use them. Then the problem becomes one of scheduling tapes so that all who wish to use them may do so.

Since it takes about two hours for a teacher to prepare a half-hour tape, the number of topics covered by this method is limited. In 1958 the Continental Classroom series, *Physics for the Atomic Age* by Dr. Harvey White, provided an excellent source of discussions at a rather advanced level. This whole series has been recorded. At the beginning of each tape an introduction was added to remind the student that this is a recording of a television program and that they will miss the visual presentation. Therefore, they should have pencils, ruler, slide rule, and paper ready to sketch all apparatus described, write down all equations and measurements mentioned, and to take careful notes. Since Dr. White does an excellent job

of describing his equipment and demonstrations and always reads the numbers and equations that he writes on the board, and because the student can make the tape recorder repeat whenever he wishes, there is very little lost because of the lack of the picture. In 1959 the series in *Modern Chemistry* by Dr. John Baxter also was recorded.

Although there has not been sufficient time to prepare all of these tapes and present them in a manner that would encourage wide student use, they have had considerable use by students who wish review, or topics at a higher level than is presented in class. Quotations from the tapes have appeared on research papers presented by some students.

A considerable investment in tape is required to record the two complete series offered by Continental Classroom and the several other good science programs offered on radio and television. Unlike a reference book, however, a tape can be reused. Some programs that lose their effectiveness when recorded or for other reasons have little use are discarded and the tapes are used to record more promising materials. When this is taken into account, all of the cost can be considered capital investment and none should be charged to expendable materials.

At Stratford High School the library of tape recordings has become as useful for teaching as the library of reference books. The time should come when groups of teachers, and local, state, or regional science teacher groups would cooperate by preparing taped lessons on their favorite topics and sharing them with their fellow teachers.

General Science

Learning in a Scientific Library

By MAURICE BLEIFELD, Benjamin Franklin High School, New York City

High school students studying science frequently have no conception of the method or nature of the scientist's work. To them, the field of science comes neatly packaged in the form of textbooks and daily lessons. They rarely comprehend the tentative, exploratory aspect of research. They do not generally understand the need of scientists to learn about the work of other scientists, including those in foreign coun-

tries. They often fail to see the interrelationships of the various fields of science.

Last summer, an opportunity arose to inquire into the value of exposing students to one of the tools of the scientist, the scientific library. It was expected that such an experience would give these students an appreciation of many important aspects of a scientist's work. The students, all thirteen to fifteen years of age, were enrolled at the summer Children's School of Science at Woods Hole, Massachusetts. They were taking the six-weeks course entitled "Biology of Life Functions," and had many occasions to utilize the richly endowed features of the area.

Through the cooperation of Mrs. Deborah L. Harlow, librarian of the Marine Biological Laboratory, one of the most complete periodical collections in the country was opened to the class. Currently, sixteen hundred different serial publications are received. Students were assigned to an hour's study of the current periodicals arranged in open racks along the wall of the reading room. By previous arrangement with the librarian, each student was permitted to remove one American and one foreign journal from the racks, and was asked to comment on both by completing the following worksheet.

Worksheet

1. Read the titles of all the publications in your section.
2. List the different countries represented.
3. Select one American publication.
   a. Write name, date, volume, and number.
   b. What field of science does it include?
   c. Where is it published, and by whom?
   d. Read the table of contents. What topics are included?
   e. Choose one article. Write its name, author(s), page numbers.
      (1) Describe briefly what the beginning of the article includes.
      (2) By what methods is the information presented (tables, graphs, drawings, etc.)?
      (3) Read the summary/conclusions. What is this part of the article based on?
      (4) What is included at the very end of the article?
4. Examine one foreign publication.
   a. Where is it published, and by whom?
   b. List the languages represented in it.
5. Comments.

On the following day, the findings of the class revealed an accumulation of considerable data. The scientific journals examined were from Australia, Belgium, Canada, Chile, Czechoslovakia, England, France, Germany, Hungary, India, Ireland, Italy, Japan, Mexico, Netherlands, New Zealand, Philippines, Portugal, Russia, Spain, South Africa, Sweden, Switzerland, Turkey, and Wales.

Among the American publications listed were: *American Journal of Botany, Annals of the Entomological Society of America, Bulletin of the American Meteorological Society, Cancer, Deep Sea Research, Journal of Mammalogy, Journal of Paleontology, Physiological Reviews, Quarterly of Applied Mathematics, Reviews of Modern Physics, Soil Science, Yale Journal of Biology and Medicine,* and *Zoologia.*

The students reported that they observed papers on a variety of topics including: atmospheric pollen and spore studies, cardiac control, cation-exchange equilibria in soils, certain effects of linkage, effect of DDT on respiratory

enzymes of insects, effect of left turns on the capacity of a traffic intersection, long-range weather forecasting in the Soviet Union, mixed tumors of the skin, production of underwater sounds by toadfish, radiation effects on mitosis, recent advances in physics, and trilobites in Colorado.

Articles began in a variety of ways:

1. The work of other scientists is quoted.
2. There is a statement of the problem.
3. Previously used methods are discussed.
4. There is an explanation of the references.
5. A table of contents is listed.
6. A summary of previous knowledge of the field is given.
7. An abstract is presented.
8. There is an explanation of how this paper fits in with what has already been written.

Charts, drawings, equations, graphs, maps, photographs, photomicrographs, and tables were used.

In general, it was observed that most of the papers concluded with a brief summary. Sometimes, there was an interpretation of the findings in the light of their significance to a specific field. Many of the papers included an acknowledgment. Practically all had a list of references; many were recent, some were rather old, and others related to scientists in foreign countries.

In the analysis of foreign publications the interesting observation was made that although French, German, Italian, and Russian journals were largely printed in their native language, frequently more than one language was represented in a periodical. For example, one journal might contain papers in English, German, and French; a Japanese journal might include papers written in English; a Russian journal might have an abstract in English at the end of each paper; and a Czechoslovakian journal could have papers in German and English with a separate table of contents in Russian. It was also noted that a Russian journal might contain a special table of contents in English although all of the papers appeared in Russian. Several Russian journals, such as the *Pavlov Journal of Higher Nervous Activity*, are published in English in this country through the cooperation of several public agencies and the USSR Academy of Sciences.

NSTA CALENDAR

As a regular feature of *The Science Teacher*, the calendar will list meetings or events of interest to science teachers which are national or regional in scope. Send your dates to *TST's* calendar editor as early as possible.

June 29, 1960: NSTA Annual Summer Meeting with National Education Association, Los Angeles, California; Luncheon meeting and afternoon session

June 29-July 1, 1960: Annual Business Meeting of Board of Directors, Los Angeles, California

September 9-10, 1960: NSTA Regional Conference, University of North Carolina, Chapel Hill, North Carolina

September 30-October 1, 1960: NSTA Regional Conference, University of North Dakota, Grand Forks, North Dakota

October 28-30, 1960: NSTA Regional Conference, Deauville Hotel, Miami Beach, Florida

November 4-5, 1960: NSTA Regional Conference, Phoenix, Arizona

December 26-30, 1960: NSTA Annual Winter Meeting with the American Association for the Advancement of Science, New York City

Elections Report, 1960

A new record for membership participation in an NSTA election was set when more than 4000 members cast their ballots to share in selecting the new officers and directors for the period of service commencing July 1, 1960.

All of us appreciate the willingness of candidates to stand for election, and we extend congratulations to those whom the voting members have called to further duties. The officers chosen this year are:

President-Elect—Dr. J. Darrell Barnard, New York University, New York City (1960-61; to be President in 1961-62).

Secretary—Mrs. Mildred T. Ballou, Station KDPS-TV, Des Moines, Iowa, Public Schools (1960-62).

Region II—*Director*—Dr. Hugh Allen, Jr., Montclair State College, Upper Montclair, New Jersey (1960-62).

Region IV—*Director*—Mr. Robert D. Binger, State Department of Education, Tallahassee, Florida (1960-62).

Region VI—*Director*—Dr. Milton O. Pella, University of Wisconsin, Madison, Wisconsin (1960-62).

Region VIII—*Director*—Dr. Donald W. Stotler, Portland, Oregon, Public Schools (1960-62).

NSTA at LA

Thousands of teachers will swarm into Los Angeles next June 26-July 2 for the annual convention of the National Education Association and the meeting of the Association's Representative Assembly. Many of the NEA departments will provide programs of interest to teachers and others in special fields. NSTA has planned or shared in planning three such offerings.

First is an NSTA luncheon session on Wednesday, June 29, in the Los Angeles Room of the Hotel Statler Hilton. Following an informal "mixer" starting at 11:30 a.m., lunch will be served at noon after which there will be a scientist speaker and three reports on NSTA by Dr. Stanley E. Williamson, Miss Helen E. Hale, and Mr. Kenneth E. Vordenberg. Chairman for planning and conducting this activity is Mr. James Campbell, President of the California Science Teachers Association (Southern Section). Tickets must be purchased at the hotel before 11:30 a.m.; price, $4.00.

Second are the sessions of the NSTA Board of Directors. The annual business meeting for 1960 will be held at the Statler Hilton on June 29 and 30 and July 1. Sessions are not "closed" and interested members of NSTA will be welcome observers—while the supply of chairs lasts. Check the hotel calendar for times and locations of sessions.

A third offering of particular interest to biology teachers will be a report of progress and further plans for the Biological Sciences Curriculum Study of the American Institute of Biological Sciences. This will be given by the director of BSCS, Dr. Arnold B. Grobman of the University of Colorado. The meeting is scheduled for 2:00 p.m. on Thursday, June 30, as one of several concurrent sessions of NEA. The meeting will be in the Assembly Room of the Hotel Alexander. Presiding will be Mrs. Archie M. Owen, Supervisor of Science, Curriculum Division, Los Angeles Public Schools.

Regional Meetings

Two regional meetings have been scheduled for the "sunny south" during the autumn of 1960. It is important to place the dates of these meetings on your calendar. Begin now to make plans to obtain released time so you can attend and will be able to complete necessary reservations for housing, etc. We invite you to bring new members to these meetings.

The first of these will be held September 9-10, 1960 at The University of North Carolina, Chapel Hill. The states from which heavy attendance is expected at this meeting are: Kentucky, North Carolina, South Carolina, Tennessee, Virginia, and West Virginia. The theme of the program will be "The Challenges in Science Teaching, K-12."

Pre-registration forms and information have been sent to teachers in the region. The University of North Carolina will make available the Parker Dormitory for housing at the rate of $3 for the two evenings.

Additionally, members may write to local hotels and motels for reservations. Neither the Association nor the planning committee, however, can be responsible for reservations at these facilities. Therefore, requests should be sent directly to these sources.

The second of these regional meetings will be held at the Deauville Hotel in Miami Beach, Florida, on October 27-29, 1960. The theme of the program is "Facing the Challenge in Science Teaching." This program has been planned to have special appeal and value to teachers in Florida, Alabama, and Georgia. It should be emphasized, however, that any and all teachers from other states are welcome to attend this meeting or the one at North Carolina. Nothing would please the planning committees more than to have other states represented, even those from faraway places such as Texas, Alaska, and Hawaii.

European Tour, 1960

NSTA's first satellite attempt into the realm of international space is on the launching pad. On July 19, thirty-four teachers and other representatives of science and education in the USA will take off by KLM for a forty-day science study tour through six Western European countries. Nearly 50 per cent of their time will be spent in conferences with our colleagues and counterparts in the six countries and in specially designed visits to schools and scientific institutions. NSTA is indeed fortunate to have the following persons serving in this professional undertaking and as our ambassadors abroad.

Dr. Abraham Raskin, *Tour Director*
Hunter College, New York City

Mrs. Mary P. Robinson, *Assistant Director*
Brookside and Crompond Schools
Yorktown Heights, N. Y.

Mr. Nicholas M. Babyock
Latimer Junior High School
Pittsburgh, Pa.

Mr. Mitchell E. Batoff
Abington Senior High School
Abington, Pa.

Miss Sara J. Bennett
Spring Grove Joint Senior High School
Spring Grove, Pa.

Miss Josephine F. Bordonaro
Onondaga Valley Academy
Syracuse, N. Y.

Mrs. Virginia Bradbury
Pocasset Elementary School
Tiverton, R. I.

Mrs. Cecil Gaines
Hutchins Junior High School
Detroit, Mich.
Miss Beatrice E. Gushee
Hollins College, Hollins College, Va.
Miss Irene Hollenbeck
Southern Oregon College, Ashland, Ore.
Mr. Paul Kahn
Junior High School 45, Bronx, N. Y.
Miss Madeline Kearns
River Dell Junior High School
River Edge, N. J.
Miss Janet L. MacDonald
Hollins College, Hollins College, Va.
Miss Mildred E. Miller
Bureau of Child Guidance of the Board of Education, New York City
Miss Ray L. Miller
Hunter College High School
New York City
Mrs. Mary G. Moore
Milford High School, Milford, Ohio
Mr. W. Allan Moore
Robert A. Taft Engineering Center
Cincinnati, Ohio
Miss Catherine N. Netzlof
Latrobe High School, Latrobe, Pa.
Miss Martha Sue Noel
Phillips High School, Phillips, Texas
Miss Gertrude M. Olson
Great Falls Senior High School
Great Falls, Mont.
Miss Greta Oppe
Ball High School, Galveston, Texas
Miss Mary M. Prohaska
Wm. Barton Rogers Junior High School
Hyde Park, Boston, Mass.
Mrs. Dorothy W. Rawson
White Plains Public School System
White Plains, N. Y.
Lt. Col. Vinton R. Rawson
White Plains Senior High School
White Plains, N. Y.
Mrs. L. Joseph Roy
Shaw Junior High School
Swampscott, Mass.
Miss Mariel M. Sayre
Norwood High School, Cincinnati, Ohio
Miss Edith M. Selberg
Colorado State College, Greeley, Colo.
Miss Louise O. C. Swenson
Masconomet Regional High School
Topsfield, Mass.
Miss Dorothy T. Tryon
Redford High School, Detroit, Mich.
Mrs. Barbara E. Van Hook
Lee's Summit High School
Lee's Summit, Mo.
Miss Katharene Walker
Rogers High School, Florence, Ala.
Mrs. Kathryn D. Ward
Beaverton High School, Beaverton, Ore.
Mrs. Gwendolyn K. Wilkins
Crofton High School, Crofton, Ky.
Mr. John E. Williams
Broad Ripple High School
Indianapolis, Ind.

It is "big news" these days when major efforts of this kind in the field of science teaching can go forward without dependence on grants or subsidies from Foundations or the Federal Government. The members of this study group are responsible for full payment of their passage and other expenses, the basic costs of which total $1175. The sum also provides for complete coverage of the modest administrative expenses necessary to conduct the project. The Association therefore is not financially obligated to meet these expenses.

We congratulate everyone who is involved in this project, and look forward to the immeasurable benefits which will undoubtedly accrue to NSTA, to the profession at large, and to the United States of America.

FSA Activities

SAAS, 1960

This year approximately 39,000 sets of student entry materials were requested for the 1960 program of Science Achievement Awards for Students (SAAS). A response was received from 2650 teachers (27 per cent more than last year) who received 26 per cent more materials than in last year's distribution. Approximately 6400 student project reports were judged in the eleven regional divisions. This number represents a 25 per cent increase over completed projects submitted last year. NSTA and the SAAS sponsor, the American Society for Metals, are highly gratified at this demonstration of interest and enthusiasm.

Unfortunately, and we repeat this to alert everyone to the rules for future programs, not all students who completed their project reports could be included in the final judging of entries. More than one hundred were mailed *after* the closing date of March 15, and therefore reached their destination after the judging had been completed. Secondly, about an equal number were mailed to NSTA headquarters instead of to the appropriate regional chairman, as directed in the instructions. Although these projects were immediately forwarded, most of them were too late to qualify.

We urge teachers to make an effort in future programs to follow carefully all pertinent instructions on mailing, deadline date, and other regulations. Otherwise, students may be penalized or discouraged for reasons not of their own making.

Plans are now being made for the 1961 SAAS competition, and there is every indication that this worthwhile endeavor will be continued by ASM. Since the SAAS program stresses entries which are reports of investigative or research-type projects, and not displays, there is no reason to wait to submit the report until after a science fair or other similar activity.

As in other years, the names of all winners of awards and honorable mention in SAAS 1960 will be published in a special brochure which will be available about July 1. Single copies will be sent free on request. Since the listing will contain titles of award-winning projects, this brochure will be an excellent source of project suggestions for other students.

FSA Youth Organization

Tomorrow's scientists are on the way. A new organization, the Future Scientists of America (FSA), designed by science teachers, approved by the NSTA Board of Directors, and administered by the Association, will be activated in September 1960. At that time, schools wishing to affiliate may make application through the FSA office at NSTA headquarters.

Several specific service programs are already in advanced stages of planning. Among these are booklets of project ideas, handbooks for teachers or other sponsors, youth science conferences, and related items.

The FSA program will provide suggestions for student projects through a series of booklets under the general title of "Vistas in Science." The "vistas" will deal with specific fields of science, such as herpetology or ceramics or oceanography, and each of the booklets will be developed in three sections. The first part will give a brief resume of the field to be considered. This will be followed by a review of current problems and the work of scientists in the field with emphasis on the "vistas" ahead. Finally, there will be a section which begins with simple, directed-type projects and leads gradually into nondirected, open-ended or research-type investigations which will stimulate and challenge the most able student.

Plans are crystallizing to encourage conferences of the kind that might be called "Youth Science Congresses." Congresses are gatherings of students who meet for the express purpose of presenting papers on investigations they have carried out. Meetings of this kind give the students additional experiences similar to those of practicing scientists in research symposia.

The handbook for FSA sponsors will provide a wide range of suggestions and specifics for group meetings and programs. The format of the handbook will be flexible so that continuous revision will be possible through deletion and through addition of materials to be provided from FSA headquarters. A modest array of club charters, plaques, student FSA pins, and certificates will be available at low cost to those who desire them.

In order to provide a continuing and expanding service to FSA sponsors and students, other suggestions are being considered. How do you feel about the following:

1. The holding of FSA leadership conferences for sponsors. Such conferences could assist new sponsors in their formulation of FSA chapters and give added incentive to existing sponsors to improve their chapters through the sharing of individual program ideas and experiences.
2. A student registry, maintained in the headquarters office, which will contain the names of those who have excelled in extracurricular science achievements and a record of the honors accorded them. One service of this registry would be the forwarding of a student's achievements, upon his request, to people or institutions directly concerned with his future plans in the scientific field.

As FSA is further developed, it seems advisable to incorporate the knowledge that every acceptable professional effort has behind it the thoughts and consultation of many individuals in forming the program. The establishment of a Field Advisory Board for FSA, made up of representative science teachers and others from science and education, is currently being undertaken to help guide us in the initial development.

Your recommendations and suggestions for the development and future plans of FSA are earnestly solicited. The door is still open for your ideas on organization, development, and program plans for youth activities. The program that we hope to have a few years from now can be successful only through your efforts and the guidance which you submit today. Write Mr. William P. Ladson, Director of Youth Activities, about your views.

BOOK Reviews

Our Mineral Resources. Charles M. Riley. 328p. $6.95. John Wiley and Sons, Inc., 440 Fourth Ave., New York 16, N. Y. 1959.

This informative volume is properly subtitled "An Elementary Textbook in Economic Geology." It is, however, not elementary in its treatment and scope; it is surprisingly comprehensive, and treats complicated processes with such simplicity that the novice can understand them. It is a veritable bonanza for the non-geologist interested in mineral resources.

The book has two major divisions: (1) metallic, and (2) nonmetallic minerals. In the first part, the author discusses iron, aluminum, copper, lead, zinc, tin, tungsten, gold, silver, nickel, chromium, platinum, uranium, vanadium, and ten other miscellaneous metals. In the second part, he discusses ground water, coal, petroleum, rock and mineral building materials, minerals for chemical uses, gems and gem stones, and three miscellaneous nonmetallics.

Following the main sections are six appendices and a seven-page index. The appendices include a seven-page glossary, a list of the chemical elements, a sketchy geologic time scale, a list of ore minerals of various metals, a list of valuable nonmetallic minerals, and a short list of general references. The glossary and ore minerals list should be particularly useful. Each chapter has its own list of selected references—a valuable feature.

Chapter I, Principles of Ore Deposition, is an excellent, graphic exposition on the processes by which minerals form in the earth. Later chapters make frequent reference to Chapter I, thereby avoiding repetition and saving space. Treatment of each mineral follows a general outline: uses, production, origin, occurrence, and geology (illustrated with graphic description of important deposits).

The text is effectively illustrated with some 40 photographs, 25 special maps, and more than 70 diagrams (block, stratigraphy, etc.).

This volume is recommended for teachers to use either as text or reference, and as a prized addition to libraries, both public and personal. Dr. Riley is to be congratulated, not only on the industry and skill his work represents, but also for the courage to compress and simplify a vast and complex subject.

Ruben L. Parson
Northern Illinois University
DeKalb, Illinois

Science and Liberal Education. Bentley Glass. 116p. $3. Louisiana State University Press, Baton Rouge 3, La. 1959.

In a series of three excellent essays based on his Davis Washington Mitchell lectures at Tulane University, Dr. Glass faces what he considers the most compelling problem in education today and offers some suggested answers which are sound and profoundly elucidated.

He says, "Science is one of the most powerful means devised by the mind of man for arriving at truth in respect to the world of matter and energy, and indeed also the realm of mind and behavior . . . in the modern world the strength of a nation, whether in war or peace, resides in its science . . . Education . . . ought then to reflect the central reality of modern life . . . the reckoning with science and the technology which is based upon it . . . We have reached a point in human history where the structure of our civilization and its staggering technology depend vitally on the sciences for support (the skeleton) and for new ideas and concepts (the seeds of progress). Education, to reflect modern life, to prepare for life, to adjust to life, must reckon with this clear reality."

Although the basis for this concern and for his proposed directions in education are to be found in genetics and the experimental study of evolutionary processes, Dr. Glass does not say that in science will we find all of the answers. On the contrary, he makes clear his firm belief that what is most needed is good judgment in matters that still lie outside the scope of the sciences—but, that the relating of knowledge and human power, acquired through science, to our world of values, is essential.

How many of our science courses, at either secondary or college level, are aimed at this purpose? Can we count on this as an automatic concomitant of the usual teaching of biology, chemistry, or physics? In my opinion, the answers to these two questions are "not very many" and "definitely, no." The author is without doubt urging that courses, or at least units in courses, be planned to accomplish purposes other than knowledge of the products of science—just as many science educators have been advocating for twenty-five years or more.

Those who read this book will be stimulated by the philosophy and wisdom of Dr. Glass, who is an eminent professor of biology at the Johns Hopkins University, and they will also gain an added insight into human genetics, the influences of radiations on human heredity, and some of the problems in eugenics.

Robert H. Carleton
Executive Secretary, NSTA

Science Education for Elementary School Teachers. Harold Tannenbaum and Nathan Stillman. 340p. $6. Allyn and Bacon, Inc., 150 Tremont St., Boston, Mass. 1960.

The authors present a uniquely fresh and sensible approach to science teaching in the elementary school: teaching methods integrated with current knowledge of child growth and development. The *child* as the learner is the central figure in the entire book, and numerous practical suggestions for good science teaching are included. The book is well written, delightfully readable, and would be an excellent choice for a college text in elementary science or for the professional library of an elementary school.

The teacher who has a real understanding of child growth and development is more likely to be competent in guiding children in learning situations. Without an understanding of how children learn, without insight into the reactions they have, without the ability to see children in relation to what is being taught, the teacher is not likely to have much success in his work. The child is an explorer, a problem solver, a searcher after himself and his world, and a social being who must be understood.

The authors discuss over-all goals for elementary science, and proceed to describe in minute detail ways in which those goals can be realized. How to *plan* is discussed—planning for individual children and planning the effective presentation of subject matter. One feels as if he is in Miss Edwards' classroom as she reads the description of the activities among her third graders as a unit on electricity is introduced—or in Mr. Benjamin's room as he introduces the study of "Making, Distributing, and Using Electric Power."

Interests as a motivating force cannot be overestimated and suggestions for capitalizing on them are made. An excellent chapter on the use of reference materials and the role of reading in science is included, followed by an equally strong chapter on measurement and quantitative concept.

Perhaps one of the most flagrant mistakes in science teaching in the elementary school is the practice resulting from confusing *experimenting* with merely *demonstrating*. The authors attack this problem squarely and vigorously. Classroom activities are described to help the reader differentiate between the two and understand the proper use of each.

An excellent science equipment list is included, as well as an annotated bibliography of children's books, suggestions for using visual aids, resource people, making class trips, evaluating children's growth, building a program for the gifted, and integrating science with other academic areas.

Mildred Ballou
Station KDPS-TV
Elementary Science Teacher
Des Moines, Iowa

SCIENCE TEACHING MATERIALS

Prepared by NSTA Teaching Materials Review Committee
Dr. Robert A. Bullington, Chairman
Northern Illinois University, DeKalb

BOOK BRIEFS

A History of Science, Technology and Philosophy in the 16th and 17th Centuries. A. Wolf. Vol. I, 350p. $1.95. Vol. II, 338p. $1.95. A Harper Torchbook. Harper & Brothers, 49 East 33rd St., New York 16, N. Y. 1959.
A monumental work, well written and illustrated and, since its original appearance in 1934, still indispensable for students of the period.

Secrets in the Dust. Raymond Holden. 178p. $2.75. Dodd, Mead and Company, 432 Fourth Ave., New York 16, N. Y. 1959.
An interesting portrayal of archeology for junior-senior high students and for general reading. Captures the drama of discovery in well-written fashion. Covers many of the discoveries in archeology, weaving them into the pattern of history. Illustrated.

What Makes a Scientist? George H. Waltz, Jr. 142p. $2.95. Doubleday & Company, Inc., 575 Madison Ave., New York 22, N. Y. 1959.
Book of biographies of twelve outstanding scientists of today. Presents their lives as filled with science interests as well as interests comparable to those of other people. Well written for junior-senior high school readers. Concludes with an analysis of "What does make a scientist?" Illustrated. Contains bibliographies.

Behind the Scenes at an Oil Field. David C. Cooke. 64p. $2.25. Dodd, Mead and Company, 432 Fourth Ave., New York 16, N. Y. 1959.
Describes the operations of the oil industry. Covers topics of discovering, processing, transporting, and refining oil. Full-page photographs help to visualize accurately the various processes. An interesting and informative source for upper elementary and junior high students.

Echoes of Bats and Men. Donald R. Griffin. 156p. 95¢. Anchor Books. Doubleday & Company, Inc., Garden City, N. Y. 1959.
A stimulating presentation of the effective ways animals make use of echoes and a comparison of these with man's artificial devices that operate on the same basic principles. Especially valuable for physics and zoology students.

101 Best Nature Games and Projects. Lillian and Godfrey Frankel. 126p. $2.50. Sterling Publishing Company, Inc., 419 Fourth Ave., New York 16, N. Y. 1959.
This nature book is an excellent collection of material for a beginning adventure or an enriching experience in the out-of-doors or the classroom. Many possibilities given for firsthand experiences in using the senses in exploring nature. A good reader for science students in grades 5-9. Well illustrated.

Rockets of the Navy. Eric Bergaust. 48p. $2.50. G. P. Putnam's Sons, 210 Madison Ave., New York 16, N. Y. 1959.
Describes briefly the development, history, and uses of the Navy's rockets and missiles. Contains a complete up-to-date set of photographs of the principal ones in use by the United States Navy. Includes a comprehensive glossary of rocket and missile terms. Recommended for junior high students.

Animal Camouflage. Adolph Portmann. 112p. $4.50. University of Michigan Press, Ann Arbor, Mich. 1959.
A well-presented discussion and selection of examples concerned with the fascinating variety of ways in which animals may demonstrate this remarkable characteristic. A topic one usually finds in scattered references.

Charles Steinmetz. Henry Thomas. 126p. $2.50. G. P. Putnam's Sons, 210 Madison Ave., New York 16, N. Y. 1959.
A biography of the scientist, Charles Steinmetz. Well written for junior high students. Captures the warmth and personality as well as the inventions of the scientist.

A Philosopher Looks at Science. John G. Kemeny. 274p. $4.95. D. Van Nostrand Company, Inc., 120 Alexander St., Princeton, N. J. 1959.
A mathematician-philosopher gives his views on a number of searching questions that scientists in general avoid. Interesting reading to one who has a philosophical bent. The uninitiated will encounter difficult sections.

Physics in Your High School. American Institute of Physics. 136p. $1.50. McGraw-Hill Book Company, Inc., 330 West 42nd St., New York 36, N. Y. 1960.
This would be a very helpful text for those school systems that consider introducing physics into their curriculum. Features such as who should study high school physics, a description of the content of high school physics, the use of the laboratory and demonstration, etc., are treated. A section on "The Physics Teacher" covers academic preparation, out-of-class duties, and classroom responsibilities. An interesting section comparing starting salaries of beginning physics teachers and beginning industrial physicists, as well as their possibilities for financial advancement, is also included. A

useful apparatus list of laboratory and demonstration items is given in an appendix.

Your Heart and How it Works. Herbert S. Zim. 64p. $2.50. William Morrow and Company, Inc., 425 Fourth Ave., New York 16, N. Y. 1959.
Contains excellent illustrations and diagrams and a clear and simple explanation of the heart and its functions. Picturesque portrayal makes book interesting and resourceful for boys and girls.

The Thirteen Steps to the Atom. Charles-Noel Martin. 256p. $4.95. Franklin Watts, Inc., 575 Lexington Ave., New York 22, N. Y. 1959.
An interesting treatment of man's quest for the understanding of atoms. Includes 118 excellent photographs of objects increasing in minuteness from snowflakes to electrons. Interestingly written as a reference book for junior-senior high school and college.

This Sculptured Earth: The Landscape of America. John A. Shimer. 256p. $7.50. Columbia University Press, 2960 Broadway, New York 27, N. Y. 1959.
A resourceful book picturing the familiar landscape of America in detail in more than sixty photographs showing nature's forces at work in the form of rivers, oceans, ice, wind, volcanic activity, and earthquakes. Gives the answers to the cause of our landscape today. General source of geological information for high school students and adults.

This is Nature: Thirty Years of the Best from Nature Magazine. Edited by Richard W. Westwood. 214p. $5.95. Thomas Y. Crowell Company, 432 Fourth Ave., New York 16, N. Y. 1959.
This is an extremely fascinating collection of favorite articles and stories that provides good reading for youngsters and adults alike. Literally a selection of the best from *Nature Magazine*. A wide range of interesting forms of wildlife is described in a variety of writing styles. Photographs and drawings enhance this very fine book. It makes a worthy contribution to classroom and home libraries.

Standard Handbook for Telescope Making. N. E. Howard. 326p. $5.95. Thomas Y. Crowell Company, 432 Fourth Ave., New York 16, N. Y. 1959.
An excellent handbook for the amateur astronomer who would like to build his own telescope. Complete step-by-step procedures are given for making and testing a telescope mirror, using realtively simple and available materials. Directions are given for making the eyepiece, the telescope tube, and the mounting. Helpful information and photographs on celestial photography. Illustrated with diagrams and photographs.

Virus. Wolfhard Weidel. 160p. $4.50. The University of Michigan Press, Ann Arbor, Mich. 1959.
An excellent general treatise on viruses. The author includes virus structure, reproduction, relations to other organisms, genetic phenomena, disease control, and viral origin. Although written in an easily understood and entertaining fashion, the book is current, accurate, and thorough. *Virus* could be extremely useful to any biologist desiring a short, current, and accurate treatment of the virus and viral phenomena.

Environmental Conservation. Raymond F. Dasmann. 308p. $6.50. John Wiley and Sons, Inc., 440 Fourth Ave., New York 16, N. Y. 1959.
This readable college text in conservation written from a biological viewpoint will make an excellent reference for secondary teachers and students interested in the environmental aspects of conservation. Stresses an ecological approach to the conservation of natural resources. Emphasis is placed upon natural land and water habitats, the biological resources they produce, and the human populations dependent upon them.

The Sky Is Our Window. Terry Maloney. 128p. $3.95. Sterling Publishing Company, Inc., 419 Fourth Ave., New York 16, N. Y. 1960.
An astronomy book written for easy reading by the average junior high school student. The illustrations are well chosen and in color. The organization starts with the obvious and ends with the more indirect observations in astronomy. With the aid of the glossary of terms, this book gives a simple, brief, and lucid picture of the nature of space and objects beyond the earth.

PROFESSIONAL READING

"Science, Literature, and Human Thought." By John Read. *Journal of Chemical Education,* 37:110. March 1960. The influence of science on the writings of Chaucer, Ben Johnson, Shakespeare, and other literary personalities serves as the central theme. Read shows how authors have drawn on science as a simile or as a method of explanation. The article concludes with the author's interpretation of the influence of science on the literature of the twentieth century.

"Life Outside the Solar System." By Su Shu Huang. *Scientific American,* 202:55. April 1960. The life history of stars gives clues as to whether or not they can support intelligent life. Photographs and diagrams are abundantly used.

"The Florence Agreement." By Robert W. Frase and Sanborn C. Brown. *Physics Today,* 13:26. February 1960. Should schools pay import duty on educational materials not manufactured in this country? The countries which have accepted the Florence Agreement do not require their schools to pay such duty. Reading the article will give you a picture of this agreement which is now under consideration by the U. S. Congress.

"Rapid Preparation of Lantern Slides." By James C. Sternberg. *Journal of Chemical Education,* 37:2. February 1960. A method of preparing lantern slides using ordinary "Ditto" carbons is explained. This technique would be a great timesaver if used in the classroom as a substitute for detailed drawings on the blackboard.

"Chemical Education Tested Demonstrations." By Frederick B. Dutton. *Journal of Chemical Education,* 37:2. February 1960. Two demonstrations are presented: one on the preparation of white from red phosphorous and the other on the kindling temperatures of chemicals. This section is a regular feature of this journal, which chemistry teachers could read profitably.

"Nature of Physics and Its Relation to Other Disciplines." By Sir G. P. Thompson. *American Journal of Physics,* 28:221. March 1960. Teachers of physics in particular and science teachers in general will find the author's treatment of the relationships between the disciplines very interesting. "Physics . . . has often grown from the study of apparent

trivialities." Such statements as this give the article a theme which physicists do not often state. The practical values as well as the scientific values of physics as a science are discussed.

"Radiation and the Human Cell." By Theodore T. Puck. *Scientific American,* 202:142. April 1960. Human cells are more sensitive to radiation than they were thought to be. Contains interesting photographs showing how radiation breaks chromosomes and then forms their abnormal recombinations. The concept of "lethal dose" is discussed.

"The Amateur Scientist." By C. L. Strong. *Scientific American,* 202:187. March 1960. Describes some useful and interesting home-made vacuum pumps and some of the things that can be done with them. Contains pictures, diagrams, and ideas for teachers to obtain more information before classroom use. This article discusses experiments and demonstrations which require a vacuum.

"Preparation of High School Science Teachers." *Science,* 131:1024. April 1960. The certification standards recommended by the Cooperative Committee of the American Association for the Advancement of Science on the teaching of science and mathematics are described. The recommendations include the academic training necessary in all the areas of science.

AUDIO-VISUAL AIDS

Our Ever-Changing Earth. A set of six filmstrips covering the many forces that affect the surface of the earth. Excellent full-color photographs, simplified diagrams, with vocabulary frames that point out new words. A very useful aid for earth science and physical geography units at the junior high school level. Each filmstrip is topically organized so that it may be used as a whole or in part. The six subjects covered are: *Work of Running Water,* 47 frames; *Work of Wind,* 41 frames; *Work of Ground Water,* 47 frames; *Work of the Sea,* 45 frames; *Work of Snow and Ice,* 48 frames; and *Work of Internal Forces,* 50 frames. Color. Set $32.40; $6 each. 1959. Society for Visual Education, Inc., 1345 Diversey Parkway, Chicago 14, Ill.

What's So Important About a Wheel? A science readiness film for the primary and intermediate grades. Shows primitive uses of wheels and many modern applications, ranging from a child's toys to giant machines. 10 min. Color $100, B&W $50. 1959. Journal Films, Inc., 2441 West Peterson Ave., Chicago 45, Ill.

Scientific Method in Action. The steps of the scientific method are clearly outlined and illustrated in use in scientific research and in daily life. The classic work of Galileo with falling bodies is re-enacted from a replica of the famous tower of Pisa. Then the main steps of the research work of Dr. Jonas Salk in his development of the polio vaccine are shown in the actual setting. This sequence is especially instructive. Useful in any junior or senior high science class. 19 min. Color $195. 1960. International Film Bureau, Inc., 57 East Jackson Blvd., Chicago 4, Ill.

Rhythmic Motions of Growing Plants. An excellent portrayal of the growth movements of plants dynamically shown by time-lapse photography. Creates interest in the topic and raises many questions that will lead into the details of auxins and their effect upon plant growth. Useful in high school and college biology courses. 10½ min. Color $90. 1958. William M. Harlow, 115 Terrace Road, Syracuse 10, N. Y.

Breakthrough—The Challenge of Agricultural Research. This superb documentary film of timely agricultural research by the USDA is most informative and stimulating to students and lay persons alike. The film shows how diligently our trained scientists develop and employ new techniques for improving our use of the basic resources. Contains an excellent cross section of research covering insecticides, metabolism in cattle, and the relationship of light to plant growth. For high school or college. 27½ min. Color. Distribution free. 1960. U. S. Department of Agriculture, Office of Information, Motion Picture Service, Washington 25, D. C.

About the Human Body. Informative film dealing with important body systems. Makes excellent use of charts, animation, and dramatic techniques involving relationships of children with physician. Muscles, bones, ligaments, and nervous, respiratory, digestive, and circulatory structures depicted and explained. Narrative excellent. Should prove valuable aid for upper elementary and junior high. 15 min. Color $165, B&W $90. 1960. Churchill-Wexler Film Productions, 801 North Seward St., Los Angeles 38, Calif.

Work and Power. Members of a high school science club are shown at a large amusement park actually living some of the experiments they have done in class. They feel centripetal force on the flying turns, inertia on other rides. The performance of work—or lack of it—is illustrated by a tug-of-war, and power by two weight lifters. This film is highly recommended for the upper grades and junior high school. Only two concepts are emphasized—work and power—and these are excellently presented. An introduction is made to such concepts as simple machines, leaving the development of these to further study. 14 min. Color $150. 1960. International Film Bureau, Inc., 57 East Jackson Blvd., Chicago 4, Ill.

Principles of Endocrine Activity. An excellent introduction to the subject presented as a professorial lecture-demonstration. Stresses the concept of coordination and control of body activities by both nervous and chemical mechanisms. By animation, locations of seven endocrine glands are shown in the frog, chicken, and human. Action of thyroxine demonstrated with frog tadpoles. Berthold's classical experiments explained. Live roosters and capons used to show hormone effects. An effective lesson for any high school or college class where endocrine activity is being considered. 16 min. Color $150, B&W $75. 1960. Audio-Visual Center, Indiana University, Bloomington, Ind.

Frog Anatomy. A highly effective presentation of the procedures of anaesthetizing and dissecting the bullfrog. The close-up camera reveals the how and why of the steps of procedure as well as the detail of the various systems examined. Excellent for use in biology courses where actual dissection is not possible or as an introduction to laboratory dissection in either high school or college classes. 17 min. Color $150, B&W $75. 1960. Audio-Visual Center, Indiana University, Bloomington, Ind.

How We Know the Earth Moves. Designed to help students understand the proofs of the earth's rotation, revolution, and the apparent motion of the stars. Demonstrates and explains the Foucault Pendulum by which the earth's rotation was first proved. Describes and explains star shift to show that the earth follows an almost circular path. Provides an actual experiment for audience participation that illustrates star shift. Recommended for upper elementary and junior high grades. 10 min. Color $110, B&W $60. 1960. Film Associates of California, 11014 Santa Monica Blvd., Los Angeles 25, Calif.

APPARATUS & EQUIPMENT

Westinghouse Atomic Power Plant Kit. Atomic power plant model in five-color plastic. May be assembled by the enclosed directions into an authentic and minutely detailed scale replica. An enclosed booklet provides a guided tour through this atomic reactor, explaining the principles of converting atomic power to electrical energy and the functions of all components. Contains comprehensive diagrams, illustrations, and suggested class projects. The assembly of the plant will lead to a fascinating study of the whole field of atomic science for the junior and senior student. Aircraft, ships, and other kits available. $5.60. 1959. Revell, Inc., 4223 Glencoe Ave., Venice, Calif.

The Graphic Periodic Selector of the Elements. This device consists of a 4¾ x 10-inch plastic jacket in which a printed card slides into various positions to permit easy comparison of the electron structure of the elements. Particularly helpful in studying how the different subshells and orbitals are filled as successive electrons are added to the atom. The similarity in structure of each element within a vertical group in the periodic chart is strikingly shown by the data which appear simultaneously in the several "windows" in the plastic jacket. Information is also given for each element concerning its atomic number, atomic weight, valence, melting and boiling points, density, natural isotopes, abundance, electronegativity, oxidation potential, covalent bond types, ionization potential, and the ionic and covalent radii. Durably constructed and useful to the student of chemistry. $3.25. 1959. Dyna-Slide Company, 600 South Michigan Ave., Chicago 5, Ill.

HECTOR REPORTS:

The NSTA staff study reported in the March issue is already a "best seller." This is a report of new trends and practices in science teaching, grades 7-12. It includes information about programs throughout the nation on science seminars, general science, earth science, physical science, biology, chemistry, and physics. Over one hundred new developments and major curriculum-planning projects now under way are described. Send your orders directly to the Publications-Sales Section of the NEA for the report entitled: *New Developments in High School Science Teaching*. $1.50. 108p.

(Members are asked to check their newly received copies of this study for missing pages. Inadvertently, some copies were released before final checking. NSTA will be glad to replace these for you, if you return the incomplete copy. Write directly to the Headquarters Office.)

Let's Work Together is the title of a reprint pamphlet which incorporates four articles on business-industry activities. These articles written by Harold E. Tannenbaum appeared in earlier issues of *The Science Teacher* and have been made available for distribution by the Business-Industry Section of NSTA. Specific activities are given in which educators and businessmen may more effectively cooperate. Single copies at no charge will be mailed upon request to NSTA Headquarters.

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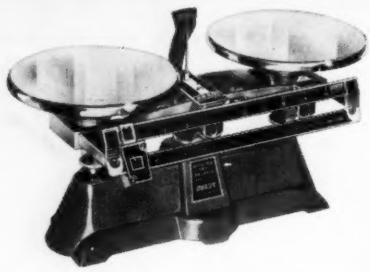

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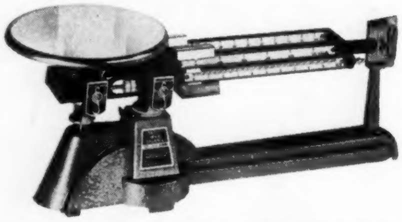

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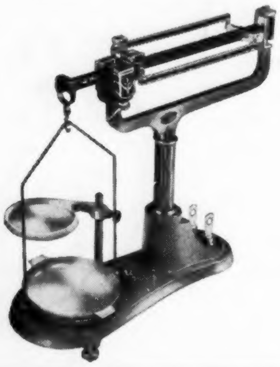

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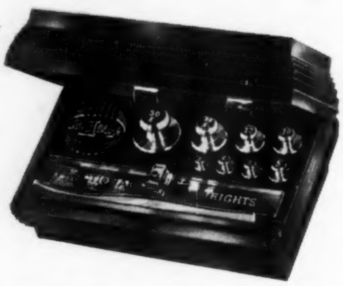

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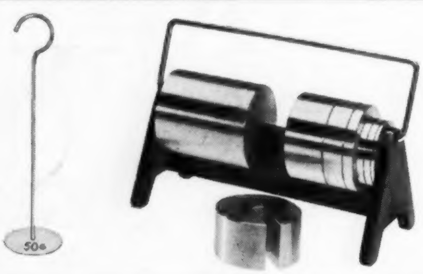

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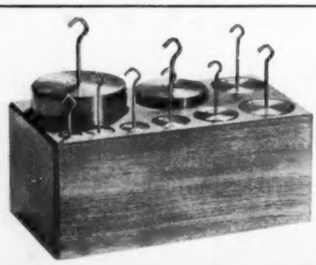

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